Biological Anthropology: An Evolutionary Perspective
Part I

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Barbara J. King, a biological anthropologist, specializes in the study of primate behavior and human evolution. Since 1988, she has taught at The College of William and Mary and has won four teaching awards: the William and Mary Alumni Association Teaching Award, the College's Thomas Jefferson Teaching Award, the Virginia State Council of Higher Education's Outstanding Faculty Award, and the designation of University Professor for Teaching Excellence, 1999–2002.

Professor King's research interests center around the social communication of the great apes, the closest living relatives to humans. Currently, she and her students observe and film the gestural communication of gorillas living at the Smithsonian's National Zoological Park, in Washington, D.C. Funded by the Wenner-Gren Foundation for Anthropological Research, this research is the basis of her new book. Tentatively titled *The Dynamic Dance: Nonvocal Social Communication in the Great Apes*, this book will be completed during Professor King's year as a Guggenheim Foundation Fellow (academic year 2002–2003).

Other books authored or co-authored by Professor King reflect her longstanding interest in the "big issues" in anthropology. One such book, *The Information Continuum* (1994), is based on her doctoral research into baboon social learning in Kenya, and two others, edited volumes, resulted from major funded conferences in anthropology (*The Origins of Language*, 1999, and *Anthropology Beyond Culture*, co-edited with Richard Fox, 2002).

Professor King received her B.A. in anthropology from Douglass College, Rutgers University, and earned both her M.A. and Ph.D. in anthropology from the University of Oklahoma. At The College of William and Mary, she focuses on teaching primate studies and human evolution to undergraduates.

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Biological Anthropology: An Evolutionary Perspective Part I

Acknowledgement:

Footage of a rhesus monkey on Cayo Santiago provided by Christy Hoffman.

Biological Anthropology: An Evolutionary Perspective

Scope:

These twenty-four lectures present detailed, up-to-date material about all aspects of the evolution of humanity. Aimed at those who are curious about our origins as a species, this course covers the wide range of topics in the discipline of biological anthropology. Biological anthropology takes as its goal a comprehensive exploration of the forces of both biology and culture that shaped human prehistory and continue to shape our lives today.

Following an introductory explanation of the various scientific approaches that together make up the field of biological anthropology, the initial lectures focus on evolution and its mechanisms. Important concepts, such as Darwin's principle of natural selection, are defined clearly, with real-life examples, and their significance is explained. What emerges from this section of the course is an understanding of why evolution and religious faith never need be opposed, whereas evolution and the theory of creationism are in direct conflict (with creationism rejected by scientists).

Applying these concepts to evolutionary history, Lectures Four through Eight explore the origins and behavior of the nonhuman primates. As primates ourselves, we humans share a 65-million-year evolutionary history with prosimians, monkeys, and apes. These lectures concentrate on primate behavior, showing how our own cognition, language, and kinship bonds developed out of the abilities present in these primate relatives. Particular emphasis is put on the great apes, such as chimpanzees, those animals closer to us genetically and behaviorally than any other.

The hominids, our extinct ancestors that walked upright, evolved from a common ancestor with the great apes nearly 7 million years ago. The anatomy and behavior of these species, ranging from the famous "Lucy," to the less well-known but equally important "Nariokotome Boy," to the cave-dwelling Neandertals, are profiled in Lectures Nine through Fifteen. These lectures highlight ways in which biology and culture intersect to allow for milestones to be reached in human prehistory.

Examples include the enlarged brain that allowed stone tools to be manufactured for the first time by hominids at 2.5 million years ago and the increasing cognitive skills and emotional ties that together led to deliberate burial of the dead by Neandertals at about 60,000 years ago. Two lectures deal with issues related to gender in prehistory, asking what we can know about the relative roles of females and males in hominid societies.

Lectures Sixteen through Eighteen are devoted to the origins of modern human anatomy, behavior, and language. Biological anthropologists have identified what they believe to be the oldest modern-human remains at about 125,000 years ago. For reasons made clear, it is unlikely that these earliest *Homo sapiens* could have evolved from Neandertals. From which hominids, then, did they arise? Was Africa the center of modern human origins, as it had been the center for early hominid evolution? We consider two competing models in evaluating these questions. One model points to Africa as the sole home of our species, whereas the other posits simultaneous evolution in Africa, Asia, and Europe.

Even more debated are the origins of modern human behavior and language. New evidence points to significant shifts in biological anthropologists' understanding of each of these topics. Sites in Africa tell us that symbolism, art, and finely crafted tools may not have first appeared at 35,000 years ago in Europe as long thought; evidence for a long evolutionary history for language is mounting as well.

The final five lectures consider modern human life in evolutionary perspective. A near-consensus conclusion in biological anthropology, that the practice of grouping humans into "races" based on supposedly genetic traits is invalid scientifically, forms the heart of Lecture Nineteen. Subsequent lectures explore ways in which evolution has tailored human anatomy and behavior, even today, to specific environmental pressures.

Also considered at length are fascinating new suggestions that modern health problems and aspects of modern health psychology have arisen as a direct result of conditions in human prehistory—conditions to which we were once adapted but no longer are. Pregnancy sickness and human mate choice are two case studies in this section.

The course concludes with a look at twenty-first century "gene discourse," in which undue power is given to genes and genetic research as panaceas for the future. An evolutionary perspective yields an understanding that the kinship we humans feel with other primate species (both living and extinct), as well as the tools we collectively have at our

disposal for solving conflicts and other problems, are based not on genetics. Rather, they stem from a dynamic interplay of biological and cultural factors at work in our long evolutionary history.

Lecture One

What is Biological Anthropology?

Scope: Many disciplines, ranging from psychology to sociology to history, take the study of human behavior as their central focus. Changes in behavioral patterns over time may be an explicit emphasis in some of these disciplines. Only in anthropology, and most especially in the subfield of biological anthropology, however, is the study of humans approached within an evolutionary framework.

This initial lecture sets the stage for our course in two major ways. We first explore the range of topics studied by biological anthropologists. Among them, we will emphasize the process of evolution; the anatomical and behavioral evolution of the primates, the larger taxonomic grouping to which humans belong (and that includes human ancestors); variation seen in modern human populations today, including the variation studied by forensic anthropologists; and the degree to which our current behavioral patterns reflect our evolutionary history.

Second, we tackle head on a question undergraduates sometimes pose: “What is biological anthropology good for? How can it help me in my own life?” An evolutionary perspective on human behavior results in more than just knowledge about dates and sites—when and where specific evolutionary milestones likely occurred. Rather, it is also a window on the past and future of our species. An entirely new way of thinking comes into focus when we consider the human species within an evolutionary perspective.

Outline

I. The discipline of anthropology is unlike other social sciences in its breadth of study generally and its use of the evolutionary perspective specifically.

- **A.** Anthropologists are well known for studying behavioral variation in societies around the world, an endeavor that has become increasingly more appreciated as the world’s cultures become increasingly interconnected.
- **B.** One subset of anthropologists, the biological anthropologists, extends this cross-cultural view by adding time depth. They explore the origins of humanity well before the time period of written records and the modern outcomes of our long evolutionary history.

II. Biological anthropologists approach their subject matter from a variety of angles within the evolutionary perspective.

- **A.** Anthropological geneticists and evolutionary theorists help clarify how processes of evolution once occurred and may now affect modern human populations.
- **B.** Primatologists study aspects—evolution, anatomy, and behavior—of the hundreds of primates living today. The primates are we humans and our closest living relatives, the prosimians, monkeys, and apes.
- **C.** Paleoanthropologists study the anatomy or behavior of the hominids, the now-extinct fossil forms that existed in the evolutionary line that gave rise to modern humans.
- **D.** Biological anthropologists interested in modern human variation conduct research to discover how and why various living populations are similar and different genetically, anatomically, and behaviorally.
- **E.** Forensic anthropologists work to identify human remains in various contexts, often with application in legal matters.
- **F.** A final group of biological anthropologists works to assess the degree to which modern human groups are “adapted to the past,” that is, are directly affected by the conditions under which our species evolved in the past.
- **G.** Biological anthropologists are likely to work with scientists from other closely related disciplines.

III. Biological anthropologists see their discipline as having genuine practical use in the modern world.

- **A.** Although names, dates, and site locations are important to the study of biological anthropology and indeed to this course, they are not at its heart.

B. The evolutionary perspective asks its students—novices and old hands alike—to embrace a shift in perspective.

   1. As humans, it may be more meaningful to think of ourselves as primates rather than as a unique species. We are not the "end product" of millions of years of evolution but one well-adapted species in an array of well-adapted species living on Earth.

   2. However, our achievements as humans have come about because of a unique mix of biological and cultural processes.

C. We may gain insight into some very down-to-earth issues by adopting the evolutionary view of human history.

   1. Why are humans prone to choking while we eat and to lower back pain as we age? Our anatomical evolution gives us clues.

   2. Why do children learn complex languages so effortlessly, without being directly taught? Our social evolution helps explain this mystery.

   3. How can we bring to bear good scientific logic in dealing with contentious issues, for example, whether perceived racial differences are rooted in biology? Understanding the facts of hominid evolution together with those of modern population variation lets us proceed based on knowledge rather than on assumption.

D. In sum, the evolutionary perspective is a way of thinking about humans' place in the world and how we can improve our lives today.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 1.

Questions to Consider:

1. Have you already encountered the subject matter of biological anthropology before embarking on this course, perhaps through reading or musing about the human evolutionary past?

2. Do you believe it is important for biological anthropology to have an applied, practical aspect, as well as a purely scholarly and intellectual function?

Lecture Two
How Evolution Works

Scope: One single concept is the best starting point for our exploration of humans in evolutionary perspective. Like all other life on earth, humans have evolved. But what, exactly, does this mean? By establishing a common set of terms and definitions, we will set about answering this question.

Evolution can be defined as a change in the genetic structure of a population. To grasp this definition, we need to understand something about genes, populations, and species. From there, we can proceed to discuss the mechanisms, or *forces*, behind evolutionary change.

Most important of the evolutionary forces is natural selection, first described by Charles Darwin in the nineteenth century. The main idea behind natural selection is that in any population, some individuals will be better adapted to their local environment than others. As a result, these individuals will have greater success than others in reproducing.

A good way to approach the study of evolution is to consider popular myths about it, then learn why these myths should be rejected. Because evolution is "only a theory," doesn't that imply uncertainty about it on the part of scientists? Can't the entire process be explained by the phrase "survival of the fittest?" Hasn't evolution in fact come to a halt in today's world? The answer to all three questions is a resounding no, and we will work to understand why.

Outline

I. The single most critical process in this course is evolution, defined as a change in the genetic structure of a population.

- **A.** All humans belong to the same species, but many human populations exist. No meaningful category exists in our species between the species level and the population level.
- **B.** Most mating takes place within, rather than between, animal populations. This is true even though populations are "open" rather than "closed"; that is, some individuals will enter or leave a single population in any given time period.
- **C.** As a rule, members of a population share a common gene pool. When this gene pool undergoes systematic change over time, evolution is said to have occurred.
- **D.** The key changes that occur evolutionarily are found, then, at the level of the gene pool.
  - **1.** The genes that make up these gene pools are frequently misunderstood. Genes rarely have the power to *determine* an individual's anatomy, physiology, or behavior. Genes interact with the environment at all stages of their functioning.
  - **2.** Genes are made up of component parts of DNA and, as such, do greatly *influence* various aspects of an individual's life.

II. Four mechanisms of change can affect the genetic structure of gene pools and, thus, contribute to evolution.

- **A.** Natural selection, the primary evolutionary mechanism, is a cornerstone concept of this course. It is closely related to the idea of differential reproductive success.
  - **1.** *Differential reproductive success* means that some individuals in a population will produce more healthy offspring than will others.
  - **2.** Because of differential reproductive success, the relative frequency of traits in a gene pool may shift over time. Traits that increase or are maintained within a population are, thus, *naturally selected*.
  - **3.** Charles Darwin came to understand the action of natural selection during and after his famous travels as a naturalist. His major contribution was to offer the scientific world, for the first time, a plausible mechanism of evolutionary change.
- **B.** *Mutation* refers to a change in the structure of DNA itself and produces raw material on which natural selection may act.
- **C.** *Gene flow* refers to the exchange of genes between populations.

D. *Genetic drift*, a mechanism at work in small populations, refers to changes in a gene pool's makeup that occur because of random events.

III. Some widely cited myths may cloud our understanding of the importance of evolution and how it works to produce change over time.

A. Isn't evolution just a theory? That is, isn't it just a good educated guess by scientists at how things work?

1. In science, the word *theory* has a very specific meaning. It refers to a set of principles that has been supported by a great deal of observation and testing.
2. For biological anthropologists, there is no doubt: humans evolved. The details of exactly how the four mechanisms interacted to produce evolutionary change may not always be known, but the process itself is not in doubt.

B. Isn't "survival of the fittest" a good enough summary of how evolution works?

1. Reproduction is the key to understanding evolution, not survival.
2. Just as with the term *theory*, the term *fittest* has a precise meaning in evolutionary science. To be *fit* means to be able to outcompete reproductively other members of one's gene pool.

C. Hasn't biological evolution been far outstripped, at least for humans, by cultural evolution?

1. Biological evolution and cultural evolution interact. Each process affects the other.
2. Humans are still subject to natural selection in many ways in today's world.

D. As we will see in the next lecture, the United States, among many Western cultures, is particularly prone to confuse myth with scientific fact when considering evolution.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 2 and pp. 89–104 in chapter 4.

Gould, *The Structure of Evolutionary Theory*, especially chapter 2.

Questions to Consider:

1. Why is it crucial to recognize the importance of reproduction over survival in the process of evolution?
2. If you heard a claim that the scientific understanding of evolution, especially human evolution, is "only a theory," how would you respond?

Lecture Three

The Debate Over Evolution

Scope: Nearly one-half of Americans, according to a recent poll, reject the idea that humans evolved from other animals over millions of years. The comparable percent in European countries is substantially lower. Why are Americans so skeptical about human evolution? Some of that skepticism may be predicated by confusion about evolution.

Biological anthropologists, along with scientists in numerous other disciplines, have a special responsibility when informing the public about evolution, particularly about the relationship among evolution, religion, and creationism.

Deeply religious feelings may be compatible with acceptance of evolution, including human evolution. As the noted scientist Stephen Jay Gould recognized, many prominent evolutionary scientists are religious and many religious leaders accept the fact of evolution.

Incompatible with acceptance of evolution, however, is belief in special creation, also called *scientific creationism*. We will uncover this incompatibility by contrasting the claims of creationists and those who espouse a newer doctrine, termed *intelligent design*, with the claims of evolutionary theory.

Outline

I. Many Americans are skeptics when it comes to accepting the fact of evolution, including human evolution.

- **A.** A substantial number of people in the United States embrace the idea of humans as "specially created" by a supernatural force within the last 10,000 years.
- **B.** Legal challenges to the teaching of evolution in the public school system continue to occur, more than 75 years after the famous Scopes Monkey Trial in the American South.
- **C.** A feeling that it is necessary to choose between one's religious beliefs and an acceptance of evolution may partly explain why more Americans are "evolution skeptics" than are Western Europeans.

II. Science, including evolutionary theory, and religion are wholly compatible; no one must choose between them, although, of course, a choice may be made.

- **A.** As Stephen Jay Gould has eloquently written, science and religion represent two very different systems of knowledge; it is their profound differences that allow them to coexist.
- **B.** Science is fundamentally predicated on observation, evidence, and hypothesis testing; without these, science has no meaning.
- **C.** Religion is based on faith; in this realm, observation, evidence, and hypothesis testing have no meaning.

III. Science, including evolutionary theory, and scientific creationism are totally incompatible; here one must make a choice.

- **A.** In the strictest form of scientific creationism, four tenets are key:
  - **1.** The Earth is young, not ancient.
  - **2.** Humans were specially created by a supernatural being.
  - **3.** The claims of evolutionary scientists are inaccurate; supposedly ancient human fossils, for instance, are misdated or misinterpreted.
  - **4.** As a science, scientific creationism deserves equal time with evolution in public schools.
- **B.** Evolutionary scientists reject these tenets point by point, emphasizing particularly that "scientific creationism" is in fact a misnomer.
  - **1.** The core ideas of scientific creationism cannot be tested according to the scientific method.
  - **2.** Scientific creationism, which is thus not a science at all, ignores or distorts well-established information and should not be taught as science in schools.

IV. Intelligent design differs from scientific creationism, yet is equally incompatible with evolutionary theory and equally rejected by almost all evolutionary scientists, including biological anthropologists.

A. Unlike scientific creationists, intelligent design advocates accept that the Earth is ancient and that species may change somewhat over time. Their ideas are, therefore, superficially more like those in evolutionary science than those in scientific creationism.

B. Intelligent design adherents, however, challenge Darwinian theory through the concept of *irreducible complexity*.

1. According to this idea, some systems are so complex and contain so many interrelated functioning parts, that they could have emerged only by design. They could not have come about by evolutionary change through small successive modifications over time.

2. The complex mammalian eye, say those who espouse intelligent design, is a good example of a phenomenon that is irreducibly complex.

C. Evolutionary scientists, including biological anthropologists, counter by explaining that we can indeed use evolutionary theory to trace the emergence of the complex mammalian eye.

1. The form of the eye can be charted, from simple to more complex, across evolutionary time.

2. Evolutionary change need not always proceed through small successive modifications, however; *punctuated equilibrium* may also occur. As devised by Stephen Jay Gould and Niles Eldredge, punctuated equilibrium is described as evolutionary stasis broken up by rapid evolutionary leaps.

D. Evolutionary science and intelligent design ideas are fundamentally opposed in how they view the origins of human life.

1. Using an argument parallel to the one about the complex eye, intelligent design advocates say that humans are complex and must have arisen by design.

2. Scientists again counter with evidence from the scientific record, noting that the mechanisms of evolution can indeed account for human evolution.

E. We conclude this lecture by affirming that biological anthropologists accept the theory of evolution as a fundamental part of their intellectual toolkit.

Essential Reading:

Gould, *The Structure of Evolutionary Theory*, especially chapter 9.

Natural History, April 2002 issue (special report on intelligent design ideas plus Carl Zimmer's column "The Evolutionary Front"), and/or *Scientific American*, July 2002 issue (article by Rennie called "15 Answers to Creationist Nonsense").

Supplementary Reading:

Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (for those who wish to read about intelligent design doctrine by one of its proponents).

Questions to Consider:

1. What questions, if any, has this lecture raised in your mind about the relationship of science and religion?
2. Why do you think the intelligent design doctrine is currently getting so much more attention than is scientific creationism?

Lecture Four

Matter Arising—New Species

Scope: Let's move to another layer of detail now in our exploration of the evolutionary process. We have considered how changes may occur within a species over time, but how do new species appear to begin with? That is, how does *speciation* occur?

Reproductive isolation is the critical process by which speciation normally occurs. As populations become isolated from each other, they respond differently to slightly different natural selection pressures. Eventually, individuals from different populations can no longer interbreed successfully. A related process called *adaptive radiation* is particularly well understood by evolutionary biologists and will provide us with a classic case study.

For this case study, we turn again to Darwin; his understanding of speciation and adaptive radiation, developed while in the Galapagos Islands observing finches and other species, still instructs us today. Further, evolutionary biologists have recently published major work on the ongoing nature of evolution among the Galapagos finches, which reinforces much of what we have learned about natural selection, as well as about speciation.

How does speciation relate to human evolution, though? Let's take the long view and consider what has happened over the last 65 million years. Before that date, no primates yet existed in the world, though other mammals flourished. Adaptive radiations since that time have resulted in the diversity of primate species we see today—more than 200. What role did natural selection play in this process? This question is best answered by considering how primates differ from other mammals.

Outline

I. We have explored how natural selection and other evolutionary forces work on established populations. How can these forces, though, account for the diversity of life on Earth? How do new species arise in the first place?

- **A.** *Speciation* is the term for the process by which new species are formed from earlier, existing ones.
- **B.** A key requirement for speciation is reproductive isolation. Two populations must be effectively separated from each other, disallowing mating between them.
  - **1.** Reproductive isolation may occur because two populations become separated by some geographic barrier.
  - **2.** Alternatively, two populations may become isolated because of behavioral barriers.
  - **3.** With either type of isolation, slightly different selection pressures begin to operate on the two populations. Slowly, differences between them mount.
  - **4.** Speciation is complete when individuals from the original two populations could no longer interbreed and produce fertile offspring if brought back together.

II. When a variety of new forms—including new related species—adapts to and fills a variety of ecological niches, we say that *adaptive radiation* has occurred.

- **A.** Adaptive radiation has occurred multiple times in evolutionary history.
- **B.** The principles of adaptive radiation are most clearly illustrated by Darwin's case study of the finches of the Galapagos Islands.
- **C.** Thirteen different varieties of Galapagos finches were noted by Darwin. These differed mostly in the shape and size of their beaks, one finch form for each island in the Galapagos chain.
- **D.** Darwin realized that these thirteen varieties had descended from one common ancestor. Each form adapted to local selection pressures during adaptive radiation.
- **E.** Biologists Peter and Rosemary Grant returned to study the Galapagos finches in the 1970s.
  - **1.** The Grants' research confirmed many of Darwin's insights.
  - **2.** The Grants showed specifically that recent, severe environmental changes caused new evolution in the Galapagos finch populations.

III. Adaptive radiations are also important in the evolution of the primates, the group that includes humans.

- **A.** Approximately 70 million years ago, no primate populations existed in the world.
- **B.** Perhaps about 65 million years ago, some ancestral rodent-like populations began to undergo new selection pressures. Through the process of speciation, primates began to appear.
- **C.** The original "push factor" in this series of speciation events is highly debated, but a likely candidate is the need to hunt tree-living, fast-moving insects for food.

IV. The nature of primate evolution can be best understood by exploring the new traits that emerged when primate species first originated. These traits still characterize the primates today.

- **A.** Five key traits distinguish the primates from other mammals.
  - **1.** Grasping hands allow primates to hold branches, fur, and objects.
  - **2.** Depth perception enables primates to judge distances accurately.
  - **3.** A large, complex brain underwrites abilities for primates to learn about the world socially from their companions.
  - **4.** Single births typically occur, followed by a prolonged period of maternal dependency.
  - **5.** Primates are highly social mammals, characterized by intense social bonds.
- **B.** With this pattern of traits as a fundamental adaptation, various species of primates adapted over time to local circumstances. Gradually, we ended up with the array of more than 200 primate species we see today.

Essential Reading:

Weiner, *The Beak of the Finch: A Story of Evolution in Our Time*.

Questions to Consider:

1. Why is it important to understand that evolution works at two levels—producing change within existing populations and creating new species?

2. In what ways can you recognize the five key primate traits at work in your own life?

Lecture Five

Prosimians, Monkeys, and Apes

Scope: With this lecture, we shift our focus away from evolutionary theory to begin a detailed exploration of our closest living relatives, the primates. Having already learned what unites primates as a taxonomic group, we will now consider the major subgroups within nonhuman primates: prosimians, monkeys, and apes. These nonhuman primates are distributed across major regions of the world's tropics (and, in a few cases, outside the tropics).

Prosimians are nocturnal, often solitary creatures, with notable anatomical specializations compared to the other primates. The ring-tailed lemur of Africa and the slender loris of Asia, however, are examples of highly social prosimians. Primatologists are just beginning to appreciate the full complexity of these prosimians' social lives, as we will discover.

All the other nonhuman primates, besides prosimians, are anthropoids. As their name implies, these creatures, the monkeys and apes, are considerably more like humans than are the prosimians. We will compare and contrast the monkeys and apes to each other and make distinctions within each category, as well.

Although some scientists had studied both wild and captive anthropoids in the early decades of the twentieth century, the relevance of such work to American anthropology was clarified exponentially in 1951. In that year, Sherwood Washburn laid out a carefully conceived (now classic) plan for using anthropoid research to directly guide and aid our understanding of human evolution. Extending over the last half-century, Washburn's influence has greatly affected our conception of the relationship between anthropology and primate studies.

Outline

I. The nonhuman primates, united by the five major characteristics we learned in Lecture Four, are found mostly throughout the tropical and subtropical regions of the New World (southern Mexico, Central and South America) and the Old World (Africa and Asia).

II. Prosimians, found only in the Old World, are the first of three taxonomic divisions of the nonhuman primates.

- **A.** Prosimians evolved first, before the other nonhuman primates.
- **B.** As a group, prosimians have some anatomical specializations that are atypical for primates as a whole.
  - **1.** Some prosimian features, particularly those relating to the sense organs, relate to these primates' nocturnal lifestyle.
  - **2.** Although prosimians do have the five primate characteristics, some are not as highly developed as among the anthropoids.
- **C.** Often, prosimians are portrayed as the least complex primates in terms of social behavior and intelligence.
- **D.** Detailed research suggests that this "least complex" generalization may be too hasty and superficial a conclusion.
  - **1.** The ring-tailed lemurs of Africa are day-living and group-living primates, with a behavioral hierarchy in which females outrank the males.
  - **2.** The nocturnal slow lorises of Asia, thought until quite recently to be relatively solitary, actually show social behaviors, such as play, grooming, and male parental care.

III. Anthropoids, the monkeys and apes, are day-living, group-adapted primates with more elaborated primate characteristics.

- **A.** Monkeys are found in both the New World and the Old World. They are relatively small-bodied, with equal-length arms and legs for quadrupedal walking and a tail.
  - **1.** New World monkeys are arboreally adapted. They vary in size, social organization, and behavior. Marmosets and muriquis, both from Brazil, illustrate some of these differences.

2. Old World monkeys may be either arboreal or terrestrial. They, too, vary in size, social organization, and behavior. A comparison of different African baboon species can illustrate some of these differences.

B. Apes are found only in the Old World. They are typically larger bodied than monkeys, with longer arms than legs for swinging through the trees and no tail.

1. "Lesser" apes, such as gibbons, are small-bodied arboreal species from Asia. They typically live in mated pairs.
2. Great apes are larger-bodied species from either Asia or Africa. As humans' closest living relatives, great apes are important for biological anthropology.
   - a. Orangutans, the red apes of Asia, are arboreal and less social than the other great apes.
   - b. Gorillas, found in Africa, live in one-male or two-male social units.
   - c. Chimpanzees and bonobos, found in Africa, are closely related species that live in bisexual communities.

IV. The study of nonhuman primates, particularly the anthropoids and even more particularly the great apes, took on added focus and significance in the year 1951. This is when American anthropologist Sherwood Washburn developed his "new physical anthropology."

A. Washburn felt that physical, now called biological, anthropology, was too focused on static measurement and classification.

B. Washburn wished to focus instead on the dynamic processes of evolutionary change and how these affected primates. He envisioned a new interdisciplinary synthesis, centering on questions of evolutionary change.

C. A major method of the new physical anthropology involved comparing and contrasting the evolutionary adaptations of different primates. A wave of Washburn's students entered the field to study the adaptations of monkeys and apes. They compared and contrasted these primates' adaptations with those of humans and their direct ancestors.

D. Washburn's reformulation of biological anthropology was a turning point in the field. A key element of the discipline today continues to be comparative research, aiming to illuminate the study of human evolution and behavior. Primate studies are, thus, an integral part of anthropology.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 5, pp. 106–132.

De Waal, *Tree of Origin*, chapter by Strier.

Questions to Consider:

1. Why might Washburn welcome the recent research showing that prosimians are not as behaviorally distinct from monkeys and apes as first thought?
2. Visit a zoo, if possible, whether in "real life" or virtually, on the Internet. Are you able to spot some obvious anatomical differences between monkeys and apes?

Lecture Six

Monkey and Ape Social Behavior

Scope: Data on monkeys and apes suggest that their extensive sociality is founded on a base of strong social bonds, which in turn, is founded on kinship or close association. The existence of kinship networks means that relatives recognize, and act preferentially toward, one another. The *matrilines* (groups of related females) of rhesus monkeys and the *patrilines* (groups of related males) of chimpanzees provide excellent examples of such kinship networks.

Rhesus monkeys transported from their native Asia to the Puerto Rican island of Cayo Santiago have been studied for 50 years. Research has shown that dominance, or a system of relative ranking, is an organizing principle of the rhesus society. The divergent paths taken by males and females in this society are mirrored in the monkeys' behavior, starting at about 1 year of age.

Long-term studies of the chimpanzee, both at Gombe, Tanzania (East Africa), and Tai, Ivory Coast (West Africa), point up some fascinating contrasts with the lives of rhesus monkeys. First, chimpanzees live in patrilines. Male-male bonds (among kin and non-kin alike) underlie many complex chimpanzee behaviors, including cooperative hunting groups and defensive patrols. Juvenile chimpanzees develop much more slowly than do monkeys; they remain dependent on their mothers for much longer, but male and female lives do eventually begin to diverge.

The lives of Cayo Santiago rhesus monkeys and African chimpanzees can shed light on human behavior, just as Sherwood Washburn predicted more than 50 years ago. Through this kind of study, we can identify fundamental primate (including human) patterns.

Outline

I. In their social groups, individual monkeys and apes form strong social bonds with selected companions.

- **A.** Some of the strongest social bonds are based on recognizing and acting preferentially toward one's relatives.
- **B.** Other social bonds are predicated on close associations, or what some primatologists call "friendships" between nonrelated individuals.

II. Some of the most well studied monkey species live socially in groups organized around *matrilines*, or groups of female relatives. Rhesus monkeys of Cayo Santiago, an island off Puerto Rico, have taught biological anthropologists much about matrilines.

- **A.** Rhesus monkeys, transported from Asia to Cayo Santiago for research purposes, live on their island in ways quite similar to their lifestyle in the wild. The matrilines form the core of each group.
- **B.** Dominance, or relative ranking of monkeys who compete for resources, is the organizing principle of Cayo Santiago rhesus monkey life.
  - **1.** Groups are ranked in relation to one another.
  - **2.** Within a group, matrilines are ranked in relation to one another.
  - **3.** Within a matriline, the rule of "youngest sister ascendancy" applies: each mother favors her newest daughter.
- **C.** Male and female rhesus monkeys begin to socialize differently in their groups at around their first birthday. Matrilineal life and the rules of dominance affect males and females quite differently.

III. Chimpanzees, which are great apes rather than monkeys, live social lives that contrast in interesting ways with those of Cayo Santiago rhesus monkeys.

- **A.** Chimpanzees live in *patrilines* that form the core of each community.
- **B.** Dominance is important in chimpanzees' lives. The male dominance hierarchy is a focus of attention within the community, with a single "alpha" male at the top.
- **C.** Male-male bonds, whether within patrilines or outside of them, also form a focus of the chimpanzee community.

1. Males work together to hunt and eat monkeys.
2. Males cooperate to "go on patrol" and protect their community borders.
3. Chimpanzee communities are vastly more male-oriented than are rhesus monkey groups.

D. Ape youngsters develop much more slowly than do rhesus monkey infants; at 1 year of age, they are still infants. Male and female lives do gradually begin to diverge in chimpanzees, however.

IV. What can biological anthropologists learn about humans from the long-term data about behavior in rhesus monkeys and chimpanzees?

A. Despite their many differences in social organization, these two species attest to the balance between cooperation and competition that characterizes group living in anthropoids.

B. Just as Sherwood Washburn envisioned, this type of comparative research has been used to forge useful conclusions about primate evolution.

1. A deep layer of primate social grouping and social bonding is present, despite variation in its form, across all primates.
2. The variation in social grouping and social bonding can be understood by looking at local conditions and selection pressures to which different species adapt.
3. Human evolution, too, proceeds according to adaptation to local conditions and selection pressures.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 6.

De Waal, *Tree of Origin*, chapters by Pusey and de Waal.

Supplementary Reading:

Sapolsky, *A Primate's Memoirs*.

Questions to Consider:

1. Imagine how the concepts of *power* and *politics* might be applied to rhesus females and to chimpanzee males striving for high rank.
2. Can you think of reasons why dominance-related behaviors would be maintained by natural selection, even though some individuals will inevitably be low ranked?

Lecture Seven

The Mind of the Great Ape

Scope: Although as we have seen, monkeys and apes may share fundamental primate characteristics, many scientists acknowledge a "watershed" in terms of cognitive abilities between them. Apes—in particular the great apes—seem capable of cognitive achievements not reached by monkeys. The ability to make and use tools is one example. In this lecture, though, we will concentrate on two other examples of great ape cognitive sophistication: theory of mind and use of complex nonvocal communication.

Having a *theory of mind* is defined as the ability to take into account the mental perspective of another individual. Humans do this without a second thought; daily, we size up what our family members and friends might know, think, or feel in a given situation. Great apes, far more than monkeys, seem to approximate this ability. Great apes appear to realize, for instance, when an associate, whether an infant or another adult, lacks knowledge in a certain situation, then act in ways to make up for that ignorance.

Further, some great apes spontaneously use complex gestures and gestural sequences. Others are able to perform in various language-like ways when exposed to human symbols. These enculturated great apes, raised in enriched environments, help guide anthropologists through aspects of the great ape mind. We will focus on the chimpanzee Ai, who resides in a research facility in Japan with her son Ayumo. The two participate in fascinating experiments that allow scientists to probe chimpanzees' cognitive abilities.

Outline

I. Apes, especially the four great apes, outshine monkeys and prosimians in terms of their cognitive abilities.

- **A.** For some scientists, this statement is a firm conclusion. They point to studies of tool-use and tool-making as support for this claim. Chimpanzees and orangutans in the wild show the most elaborated technologies of any primates other than humans.
- **B.** For other scientists, this statement is a hypothesis that needs further testing. They note that some wild monkeys, for example, capuchins, have been found recently to use tools in ways that rival what chimpanzees do and exceed what gorillas and bonobos do.

II. *Theory of mind* is one area in which great apes seem clearly capable of higher cognition compared to other nonhuman primates.

- **A.** Having a theory of mind means that one individual can take into account another's mental state, that is, take into account what that second individual might know or believe about the world.
- **B.** A series of experiments, some formal and some informal, demonstrate that great apes behave as if they can figure out a companion's mental state.
  - **1.** Chimpanzees will warn companions who lack knowledge of impending danger but refrain from warning companions who are already aware of the danger.
  - **2.** Monkeys do not reliably distinguish between their companions' state of knowledge versus ignorance in the face of danger.
- **C.** Observations in the wild back up the claim for theory of mind, especially in chimpanzees.
  - **1.** Chimpanzee mothers teach their offspring more often than do monkey mothers, thus giving evidence that mothers recognize their offspring's ignorance.
  - **2.** In some situations, chimpanzees show empathy to others in ways that are consistent with theory of mind.

III. Complex communication is another context in which great apes amaze scientists, achieving heights not reached by any monkey.

- **A.** Vocal communication is not a good candidate for supporting the "ape watershed." That is, great ape vocal communication may differ little from that of other nonhuman primates.
- **B.** Gesturally, however, apes excel compared with monkeys.
  - **1.** Great ape gesture may be both intentionally communicative and iconic, that is, indicative of specific actions that social companions should take.

2. Some great apes "converse" using strings of gestures put together in meaningful sequences.

C. Enculturated great apes, those raised in enriched captive environments, surprise scientists by mastering use of human symbol systems.
   1. The chimpanzee Ai, part of a Japanese research project, can solve problems and communicate with symbols on a computer.
   2. Ai's son Ayumo has, at a very young age, learned some knowledge of these symbol systems.
   3. Results from the Ai project dovetail nicely with results from other enculturated ape research in the United States, primarily the project involving the bonobos Kanzi and Panbanisha.

IV. Profound implications for the study of human behavior emerge from consideration of the monkey-ape watershed.

A. Part of the great ape adaptation is the ability to use higher cognition and sophisticated communication abilities in negotiating everyday life.

B. Great apes represent a "baseline" from which to model the action that occurred during human evolution.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 7.

I strongly recommend viewing a Web site about Ai. Go to a good search engine, such as www.google.com, and type in "Chimpanzee Ai's homepage."

Supplementary Reading:

Savage-Rumbaugh and Lewin, *Kanzi*.

Questions to Consider:

1. Can you recall a recent incident in which you used theory of mind to predict or understand a companion's actions? Can you recall an instance in which a young child could not, yet, take another's perspective?
2. To what use do you think the chimpanzee Ai's abilities, as seen in the research laboratory, might be put in her natural African habitat?

Lecture Eight
Models for Human Ancestors?

Scope: Previous lectures have demonstrated that we humans inherit from other primates, especially the great apes, an evolutionary legacy based on strong social bonds and rudimentary abilities in technology, cognition, and language. But can data from great apes help us to model the evolution of the human species more directly?

Biological anthropologists use three types of models to elucidate how human behavior, including cognition and communication, may have evolved from a nonhuman primate foundation. Referential models claim that the behavior of one specific nonhuman primate is the single best referent for some human ancestor. One model suggests, for instance, that the evolution of human hunting can be illuminated by an analysis of chimpanzee hunting behavior.

Other anthropologists, preferring to broaden the source base, look not just at one nonhuman primate but at all four types of great apes. If some behavioral trait is found in all the great apes, then a claim for its appearance in early human evolution is strengthened. According to this approach, because hunting is so variably expressed among the different great apes, caution must be used in drawing conclusions about the evolution of hunting behavior in humans.

Finally, conceptual models may be used. Evolutionary processes, rather than specific primates, are the focus of conceptual models. Regarding hunting, a conceptual model would attempt to look at the natural selection pressures that seem to push nonhuman primates to hunt, then try to apply those pressures to understand the development of human hunting.

Outline

I. With data amassed on the evolutionary baseline represented by the great apes, biological anthropologists endeavor to model changes during the period of human evolution. Over the 50 years since Washburn first popularized this method, increasingly more complex models have appeared.

- **A.** Of all animals, it is the great apes with which humans share the most *homologies*, those characteristics arising from closely shared descent.
- **B.** The most balanced evolutionary models look not just at great ape-human similarities, or great ape-human differences, but at both. Thinking about one side without the other is unproductive.

II. Some biological anthropologists construct *referential models*.

- **A.** In referential models, one “best fit” primate is taken as a referent, or “stand-in,” for early humans. In Washburn’s day, the species of choice was the East African baboon, based on its savanna adaptation.
- **B.** Chimpanzees are now the most popular choice for the “best fit” great ape, based on the complexity of their social bonds and cognition.
- **C.** The evolution of human hunting has been modeled referentially with provocative results. As we know, chimpanzees do hunt cooperatively in groups, and their behavior may shed light on how and why early humans began to hunt.

III. Other biological anthropologists prefer broader based models, referred to as *phylogenetic models*.

- **A.** These anthropologists say that it is misleading to rely so heavily on only one type of great ape. Referential models are likely to under-represent the differences between great apes and humans.
- **B.** Humans are equally as related to bonobos as they are to chimpanzees. No reason exists to “privilege” the chimpanzee over the bonobo in a referential model.
- **C.** None of the great apes besides chimpanzees hunts. There is no strong phylogenetic basis for modeling a specific pathway for the evolution of human hunting.

IV. A third group of biological anthropologists embraces conceptual models.

- **A.** As its name implies, a *conceptual model* focuses not on certain kinds of primates but on certain concepts and processes. These relate to evolution and how change may occur over time as primates respond to selection pressures.
- **B.** In conceptual models, all nonhuman primates showing the behavior(s) of interest, not just the great apes, are eligible to be included in the modeling process.
- **C.** In predicting aspects of the evolution of human hunting, then, a population of hunting monkeys is as revealing as a population of hunting chimpanzees. A classic example involves a model based in part on a group of Kenyan baboons that, for a time, hunted intensively.

V. The question, then, is not *whether* to use nonhuman primates as models but *how* to use them.

- **A.** Referential, phylogenetic, and conceptual models are critically important because the fossils and archaeological sites connected with early human evolution yield relatively few clues about behavior.
- **B.** The best models will yield predictions that can be tested by the fossil record of human evolution, a topic to which we turn in the next lecture.

Essential Reading:

De Waal, *Tree of Origin,* chapter by Byrne.

Questions to Consider:

1. Can you think of objections that those who make referential or phylogenetic models might raise against the process of conceptual modeling?
2. Which of the three types of models do you find most persuasive for understanding the evolution of human hunting? Why?

Lecture Nine

Introducing the Hominids

Scope: What is the relationship of the first human ancestors to the great apes? Where, and at what point in time, did the first human ancestors appear? How did these newly evolved primates differ from the great apes?

In seeking to answer these questions, we will introduce the hominids, the group of primates loosely considered to be human ancestors. (Some hominids, as we will see, are direct human ancestors, whereas others appear to be side branches.) The hominids evolved in Africa, at 6 or 7 million years ago. They diverged from a common ancestor with the African great apes, but the specific form of this ancestor is something of a mystery to biological anthropologists, because no fossils of it have yet been found. Using evolutionary theory and molecular anthropology, however, we can derive clues about the common ancestor.

We next explore some basic facts about how hominid fossils are discovered and named. We consider, in an introductory way, how these hominids differ anatomically from the great apes. A major distinction can be found in the locomotion system. Great apes are knuckle-walkers and brachiators that may walk erect for short distances but quickly tire when bipedal. By contrast, the earliest hominids are adapted for true upright walking. We consider a few of the many theories for why bipedalism may have evolved through natural selection.

Outline

I. Hominids include human ancestors, those that evolved directly into *Homo sapiens* and others, dating back to the time of divergence from the African great ape lineage.

- **A.** The hallmark of the hominids is bipedalism. More than any other factor, walking upright separates the early hominids from the great apes.
- **B.** The earliest hominids are all found in Africa.
- **C.** These early hominids did not evolve directly from the African great apes. Hominids and African great apes shared a common ancestor. The form of this common ancestor was likely quite generalized.

II. The timing of the hominid-great ape divergence from a common ancestor is hotly debated.

- **A.** As recently as 30 years ago, biological anthropologists thought that the oldest hominids were approximately 3 million years old.
- **B.** In recent decades, the date for the earliest hominids has essentially doubled; that is, we now have evidence for hominids dating back to 6 or 7 million years ago.
- **C.** The divergence of hominids from great apes, then, logically must have occurred before about 6 or 7 million years ago.
- **D.** Finding a fossil of the common ancestor of hominids and African great apes would help our understanding greatly, but no such fossil has yet been located.
- **E.** Molecular anthropology provides an additional source of information about the common ancestor.
  - **1.** Comparison of molecules (proteins) across species tells us that orangutans speciated first, gorillas next, chimpanzees and bonobos next, and hominids, of course, last.
  - **2.** The timing of these speciation events can be estimated by constructing a molecular clock using rate of mutation in genetic material. A calibration date from the fossil record is imposed on the relative relationships already assessed. The result suggests that the common ancestor of hominids, chimpanzees, and bonobos lived at around 6 or 7 million years ago.
  - **3.** Not all biological anthropologists accept the molecular clock. Some say its method is flawed. They point out that as the timing for the earliest hominids is pushed back closer and closer to 7 million years, the speciation date derived by the clock seems more and more unlikely.

III. Unlike the situation with the common ancestor, scientists have uncovered fascinating bits of information about the very earliest hominids. Interdisciplinary research teams must work out whether or how their finds fit into existing "family tree" schemes of hominids.

- **A.** "Fossil hunters" go to Africa in interdisciplinary teams to scour likely sites for skeletal remains of the earliest human ancestors. Biological anthropologists are key members of such teams.
- **B.** Deciding whether skeletal material uncovered represents another individual in an already known species or is different enough to warrant naming a new species is tricky business for researchers.
  - **1.** Recall that two animals can be designated as belonging to two different species only when they cannot interbreed and produce fertile offspring. This test is difficult to apply to fossils.
  - **2.** Scientists must choose a Latin scientific name for their specimens—whether an existing name or a new one.
    - **a.** The binomial Latin system indicates, as with the example *Homo sapiens*, genus first and species second. The name chosen conveys extra information, as well.
    - **b.** Great debates often break out when scientists name new hominid species, with others in the field lining up to agree or disagree.

IV. Most of the data about early hominids involve anatomical adaptations. As we have seen, bipedalism is the key hominid adaptation. Biological anthropologists offer a number of theories to explain why early hominids are so differently adapted, compared with great apes, in their locomotor system.

- **A.** Natural selection operates from a starting point of the existing variation already present within a population. The fact that great apes—and thus, likely, the common ancestor—can walk bipedally for short distances is important.
- **B.** Some anthropologists point to climate change as the key factor leading to evolution of habitual bipedalism.
- **C.** Other anthropologists look instead at dietary selection pressures in the development of bipedalism.
- **D.** As we will see in the next lecture, the modern bipedal gait probably evolved only gradually in hominids.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, pp. 133–35 in chapter 5.

Marks, *What It Means to Be 98% Chimpanzee*, chapters 1 and 2.

Supplementary Reading:

Investigate the Internet site www.tamu.edu ("Anthropology in the News" at Texas A&M University) for recent updates on new hominid fossils or new interpretations about existing hominid fossils. Checking this site occasionally over the time period during which you listen to these lectures almost guarantees that you will discover vital new information on this topic.

Questions to Consider:

1. Why would it be unlikely (not impossible but unlikely) for the common ancestor of hominids and African apes to have already evolved bipedality?
2. Can you think of other possible selection pressures than the ones described here for the development of bipedality?

Lecture Ten

Lucy and Company

Scope: Almost 30 years after its discovery in Ethiopia, one of the world's most well known hominid fossils still informs us about our early evolutionary history. In this lecture, we will focus on the hominid known as "Lucy," who lived approximately 3 million years ago, and on other hominids alive at the early period of human evolution.

"Lucy," better known to science as *Australopithecus afarensis*, was a short, apparently female, upright-walking hominid with a small, ape-sized brain. Uncovering a creature with this combination of traits stunned scientists, who had long theorized that brain-size increase occurred soon after the divergence between great apes and hominids. Lucy was proclaimed the oldest hominid, the one at the base of the ancestral family tree of humans.

The conclusion that Lucy and her kind were bipedal has stood the test of time. Debates begun in the mid-1970s still rage, however, about the specific form of her upright walking: Was her gait modern, like our own striding walk? No agreement has been reached on this issue.

Further surprises were in store for biological anthropologists. As it turns out, at 3 million years old, Lucy was nowhere near the oldest hominid. The base of our family tree has been extended by more than 3 million years, as noted in the previous lecture. We can now see that even in our earliest evolution, multiple hominid forms coexisted—and they were bipedal from the first.

Outline

I. The year 1974 was a turning point for paleoanthropology; in this year, "Lucy" was found.

- **A.** The anthropologist Don Johanson went to Hadar, Ethiopia, in 1973 to search for hominid fossils. He found a bipedal knee dated to 3 million years ago.
- **B.** Returning the following year, Johanson made a stunning find of a 40% complete skeleton, also of a bipedal creature. The skeleton, nicknamed "Lucy," dated to 3.2 million years.
- **C.** The two Hadar discoveries rocked the paleoanthropology world, because until then, scientists had fully expected to discover that large brains had evolved before upright walking in the hominid line. Yet Lucy had an ape-sized brain.
- **D.** Johanson and his team named their fossil *Australopithecus afarensis* and described her anatomy as fully as possible.
  - **1.** Johanson described many of Lucy's traits as "intermediate" between apes and humans. Her teeth are a good example.
  - **2.** It is a misunderstanding to conclude from this intermediate status that Lucy is a "missing link" of evolution. Because humans did not evolve from apes, there is no missing link.

II. Other examples of *Australopithecus afarensis* were found in East Africa, also showing bipedalism. Yet scholars began to debate, and still do debate, whether this bipedalism could have been modern in form.

- **A.** We now have more than 350 fossils, representing probably about 100 individuals, assigned to the species *Australopithecus afarensis.* This species lived from about 3.6 to 3 million years ago.
- **B.** Johanson and his team are adamant: Though the anatomy of this species was in some ways ape-like, its bipedalism was advanced and obligatory. That is, Lucy and her kind had evolved so far in the bipedal direction, especially in the pelvis, that they were obligated to move as fully bipedal creatures.
- **C.** Opponents of the idea of 3-million-year-old bipedalism insist that Lucy's intermediate anatomy precluded modern bipedalism. They analyze not only Lucy's pelvis but her legs and arms as well, concluding that *A. afarensis* was well adapted for tree-climbing.
- **D.** Few conclusions can be reached about the social behavior of *A. afarensis*; this species is a key candidate for nonhuman-primate behavioral models, whether referential, phylogenetic, or conceptual.

III. Lucy remains a classic find in paleoanthropology but has been dethroned as the oldest hominid on record.

- **A.** As of this writing, the earliest hominid appears to be a species called *Sahelanthropus tchadensis* that lived in Chad at about 7 million years ago. Both the antiquity and the location of this fossil have surprised paleoanthropologists, as does its unusual mix of anatomical traits.
- **B.** Before the announcement in 2002 of the discovery of *Sahelanthropus*, another hominid called *Orrorin tugenensis* (nicknamed "Millennium Man" for the year in which it was discovered) was thought to represent the oldest hominid. Although little technical analysis has yet been published about this hominid, researchers say that Millennium Man's legbones indicate definite bipedality.

IV. Other species, too, existed before or along with *Australopithecus afarensis.* Rather than learning technical details of each hominid's anatomy, we will describe some examples. The main "take-home" point is that even very early after hominid divergence from the common ancestor, different hominid species coexisted.

- **A.** Maeve Leakey has been instrumental in uncovering previously unknown hominid species. An example is a second early species in the genus *Australopithecus.* Dubbed *Australopithecus anamensis*, this hominid lived in Kenya at 4.2 million years ago.
- **B.** Most stunning of Leakey's findings is a species, again from Kenya, that actually coexisted with Lucy. It looked different enough to be assigned a wholly new genus; it is termed *Kenyathropus platyops* (the "flat-faced" hominid).
- **C.** This recent flowering of hominid discoveries presents challenges for scientists, as well as for new students of biological anthropology. Our picture of the hominid family tree is changing. We now know that human evolution did not occur in a linear fashion, with one species succeeding another. The emerging picture is much more complex.
- **D.** Coexisting species played a major part in the story of human evolution after Lucy's time, as well. It is to this next phase and its cultural advancements that we turn in Lecture Eleven.

Essential Reading:

Johanson and Edey, *Lucy.* (Please read annotation in bibliography first.)

Supplementary Reading:

Visit www.zstarr.com/iho/ ("Institute of Human Origins" run by Don Johanson) for the latest information on this research team's always exciting work.

Johanson, *In Search of Human Origins* (video), 1994, PBS Nova Series. Part I is especially recommended for its stunning visuals of Hadar and Lucy.

Questions to Consider:

1. What are two aspects of *Australopithecus afarensis* that were unexpected by scientists at the time of its discovery?
2. In what significant ways has the human family tree been redrawn in the last decade or so?

Lecture Eleven

Stones and Bones

Scope: Fifty years before Lucy's discovery, the first australopithecine was found in South Africa. Dated to more than 2 million years ago, that hominid, we now know, comes from one of the two major lineages that coexisted in the time period after Lucy's existence. We can contrast the anatomy of these two lineages, but they have left behind virtually no cultural traces.

At about 2.5 million years ago, a revolutionary new ability appeared on the hominid scene. For the first time, with the larger-brained *Homo habilis*, hominids began to modify stone tools. The process sounds simple to us today. One rock was bashed against another to produce two tools: a larger core and a smaller sharp flake. The tools could then be used in efficient food-gathering. Here was a behavior that, to our knowledge, no chimpanzee or earlier hominid had ever accomplished.

Was tool-making associated with other advances in hominid lifestyles? An early, influential model of *Homo habilis* lifestyle suggested that many modern human behaviors, including sharing food and living in semi-permanent base camps, had already evolved by 2 million years ago. Newer models are more cautious but agree that *Homo habilis* was an innovator: These hominids processed animal carcasses and, in so doing, transported both animal bones and Oldowan stone tools around the landscape. This planning behavior points to an intelligence that reflects the increased brain size of the *Homo* genus.

Outline

I. Exactly 50 years before Lucy's discovery, the South African anatomist Raymond Dart uncovered the very first fossil to be categorized as an australopithecine.

- **A.** The year 1924 was another watershed—as was 1974—for paleoanthropology. Finding a skull embedded in rock matrix, Dart came to realize that he was holding an ancient human ancestor.
  - **1.** Dart knew immediately from the skull's anatomy that this individual had walked bipedally.
  - **2.** He named the individual *Australopithecus africanus.*
- **B.** *Australopithecus africanus* is an example of a *gracile hominid*. Gracile species are those that are relatively slender and light-boned, without any major skeletal specializations.

II. Other early hominids in the very same genus of *Australopithecus* are differently adapted in the skeleton and skull; they are referred to as *robust hominids* to set them apart from the gracile ones.

- **A.** Examples of robust hominids are *Australopithecus robustus* in South Africa and *Australopithecus boisei* in East Africa.
- **B.** These hominids, as their name implies, are heavier and heavier-boned. The main difference between robust and gracile species lies in the dentition, however, and in associated features of the skull.
- **C.** Two lines of evidence suggest that robust hominids ate tougher, harder foods than did gracile hominids.
  - **1.** Skeletal and muscular differences point to a dietary divergence.
  - **2.** Comparative microscopic evaluation of the teeth results in an identical conclusion.
- **D.** The robust forms went extinct at about a million years ago, perhaps because of overspecialization. During their long reign, they coexisted not only with *Australopithecus africanus* but with a new gracile form, *Homo habilis*, that appeared at around 2.4 million years ago.

III. With *Homo habilis*, paleoanthropologists see a major advance in the area of behavior: Modified stone tools are associated with this species.

- **A.** The Leakeys, a famous paleoanthropology family, discovered a new, more advanced gracile hominid living at the site of Olduvai Gorge, Tanzania.
- **B.** Recognizing the new hominid's enlarged brain size and its association with modified stone tools, Louis Leakey named the find "Handy Man" or *Homo habilis.*
- **C.** The inventor of the Oldowan tools may or may not be *Homo habilis.* The very first examples of modified tools predate the earliest *Homo habilis*, leaving researchers with an unsolved mystery.

- **D.** The stone tools, named Oldowan, represent fairly simple technology in that one rock was used to strike flakes off another rock. Two tools, the core and the flake, result.
- **E.** Oldowan tools were likely all-purpose in nature. They probably aided *Homo habilis* in various aspects of foraging, ranging from meat to plant processing.

IV. Beyond Oldowan tool manufacture, how modern-like were groups of *Homo habilis*? This question has been a point of contention for 25 years.

- **A.** The archaeologist Glyn Isaac published a highly influential model of *Homo habilis* behavior in 1978.
  - **1.** Isaac saw in archaeological sites of 2-million-year-old *Homo habilis* evidence for food-sharing and semi-permanent base camps.
  - **2.** He interpreted this hominid as being fundamentally humanlike in many of its behavioral adaptations, relying heavily on modern forager peoples to flesh out his inferences.
- **B.** Other archaeologists, notably Richard Potts, challenged Isaac's formulation.
  - **1.** Potts was skeptical that the gracile, relatively defenseless *Homo habilis* would have shared food at base camps. He pointed out that many dangerous African predators, for example, the big cats, would have competed with these hominids for meat.
  - **2.** Potts offers an alternative "tool cache" interpretation of the archaeological material found at *Homo habilis* sites. In this model, Oldowan tools were strategically placed by hominids around the landscape for food processing. No food-sharing or base camps were evident, however.
- **C.** Without a doubt, despite the controversy about its humanlike status, *Homo habilis* is responsible for some new cultural behaviors on the hominid scene. These individuals processed animal bones and brought together the animal bones and modified stone tools in new ways. The enlarged hominid brain likely played a role in these innovations.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapters 9 and 10.

Supplementary Reading:

Potts, *Early Hominid Activities at Olduvai*.

Questions to Consider:

1. Discuss how natural selection (and different selection pressures) might help explain the significant anatomical differences between gracile and robust australopithecines.

2. Which model of *Homo habilis* behavior, Isaac's or Potts's, do you find more convincing? Why?

Lecture Twelve
Out of Africa

Scope: The human lineage clearly originated in Africa, and all the hominids we have considered so far were confined to that continent. Shortly after 2 million years ago, however, a new hominid evolved and almost immediately migrated out of Africa. *Homo erectus* was a wanderer right from the beginning. In fact, *Homo erectus* is considered by many anthropologists to represent a major shift point in human evolution in several ways.

The tools used by *Homo erectus* are more varied and more efficient than are the Oldowan tools. The hand ax is a good example of a tool that makes its appearance at this point in human evolution. Evidence from China and elsewhere also suggests that *Homo erectus* probably was able to control fire, an ability that would have significantly enhanced this hominid's survival in major ways.

Because of its bi-continental distribution, *Homo erectus* is a good test case for the claim that natural selection shaped hominid adaptation. Do *Homo erectus* fossils in Africa look significantly different than those in Asia? In some ways, yes, as the wonderfully complete "Nariokotome Boy" skeleton tells us. This fossil, found in Kenya, shows that a 12-year-old boy was extremely well adapted to tropical conditions. Some biological anthropologists even suggest that such differences are enough to place African *Homo erectus* in a different species than its Asian counterparts, but recent evidence strengthens the case for a single-species interpretation.

Outline

I. As we have seen, the situation in early human evolution is both confused and confusing. Before moving forward, we will review some of the major conclusions of the time period between 7 and 2 million years ago.

- **A.** All early hominids were bipedal and lived entirely in Africa; they were concentrated in East and South Africa.
- **B.** Designation of the "oldest hominid" keeps shifting, but we know for a certainty that multiple forms coexisted even very early.
- **C.** It is debatable which of several early forms gave rise to the first hominid in our own genus, *Homo habilis.* A gracile hominid, rather than a more specialized robust one, is a likely candidate.
- **D.** Behaviorally, significant advances were reached at about 2.5 million years ago. Animal carcasses were processed at this time by *Homo habilis* using modified stone tools.

II. Perhaps the single most critical shift in human evolution occurred with the hominid that first appeared at 1.9 million years ago. *Homo erectus*, possibly a descendant of *Homo habilis*, has been known to science since the late nineteenth century. More and more details of its behavior are emerging from recent paleoanthropological inquiry.

- **A.** *Homo erectus*, discovered by Eugene Dubois on the island of Java, is the first hominid species to live on two continents: Asia and Africa. (Some biological anthropologists even claim that a few early European fossil forms are from *Homo erectus*, but this assertion is highly controversial.)
- **B.** A recent surprise is that *Homo erectus* reached Asia very early in its time period—by about 1.8 million years ago. This is a much earlier migration than earlier realized, thanks to great scientific improvements since Dubois's day.
- **C.** Putting together information from Africa and Asia, we can point to major innovations in the behavior of *Homo erectus* compared with that of *Homo habilis.*
  - **1.** The *Homo erectus* toolkit is more advanced and more varied than were Oldown tools. The staple tool was a biface, a core worked on both sides. The hand ax is a good example.
  - **2.** *Homo erectus* almost certainly ate more meat than did earlier hominids. As we will discuss later (in Lecture Fourteen), it probably survived by increasingly efficient scavenging rather than regular hunting.

3. Judging by evidence in such sites as Zhoukoudian, China, *Homo erectus* may have controlled fire. This behavioral adaptation would have allowed for advances in cooking, predation, defense, and temperature control.

III. How does the anatomy of *Homo erectus* underwrite or support the behavioral milestones just discussed? Do African and Asian forms of this hominid differ anatomically?

- **A.** The single most complete *Homo erectus* skeleton yields a wealth of information about the anatomy of at least some individuals.
  1. Found in Kenya in 1984 (with excavation continuing into 1985), the so-called Nariokotome Boy died at about age 12. He stood 5 feet, 3 inches tall and would have been over 6 feet tall had he lived to adulthood.
  2. Like other *Homo erectus* individuals, this one had an enlarged brain compared to all earlier hominids.
  3. The best way to describe the Nariokotome Boy's adaptation is hypertropical. That is, his long, slender limbs and his generally elongated body were products of natural selection for living in the tropics.
- **B.** *Homo erectus* individuals living in Asia do differ somewhat; some scientists say the difference is pronounced enough to warrant a separate species designation, but we will not adopt this "splitter" taxonomy. There is no reason to suggest that the two forms would have been prevented from interbreeding had they met.

IV. Though *Homo erectus* did overlap with other hominid forms, it seems likely that all its behavioral advances allowed it to outcompete other hominids. It seems clear (at least for now!) that *Homo erectus* is a direct ancestor of *Homo sapiens.*

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 11.

Questions to Consider:

1. Discuss both biological and cultural ways in which *Homo erectus* represents a critical shift point in human evolution.
2. What role do you think is played by unusually complete hominid fossils, such as the Nariokotome Boy and Lucy, in informing those people who are reluctant to accept that humans have evolved?

Timeline

Prehistory

(**Note**: Biological anthropologists frequently revise these dates, updating them according to new information. Included here are the current best estimates. The abbreviation *mya* stands for "million years ago.")

70 mya .... Age of Dinosaurs nears an end; no primates yet exist

65 mya .... Age of Mammals begins; ancestral primates appear

55 mya .... Earliest definite primate

55–6 mya .... Numerous speciation events produce ancestors to today's prosimians, monkeys, and apes

8–7 mya .... Common ancestor to African apes and hominids

approx. 7 mya .... First hominid, perhaps *Sahelanthropus tchadensis*

4.2 mya .... First australopithecines

3.2 mya .... Time at which "Lucy" lived (*Australopithecus afarensis*)

2.5 mya .... First hominid-modified stone tools

2.4 mya .... First hominid in the *Homo* genus, *Homo habilis*

1.9 mya .... First *Homo erectus*, in Africa

1.8 mya .... Some populations of *Homo erectus* migrate out of Africa to Asia

130,000 .... First Neandertals

125,000 .... First *Homo sapiens*

30,000 .... Disappearance of Neandertals; *Homo sapiens* is the only surviving hominid

History

1856 .... First Neandertal discovery, in Germany

1859 .... Charles Darwin publishes *On the Origin of Species*

1891 .... First *Homo erectus* discovery, in Java

1924 .... Raymond Dart finds first australopithecine, in South Africa

1925 .... Scopes Monkey Trial in Tennessee

1951 .... Sherwood Washburn outlines the new physical anthropology

1960 .... Jane Goodall begins observations of wild chimpanzees

1968 .... Washburn and Lancaster publish "Man the Hunter" paper

1974 .... Don Johanson uncovers "Lucy" in Ethiopia

1978 .... Glyn Isaac publishes theory on *Homo habilis* behavior

1984-1985...................................... Discovery of "Nariokotome Boy" (*Homo erectus*) in Kenya

1990s .... Excavation of African sites showing that early modern behavior did not originate exclusively in Europe

2002 .... Announcement of the fossil discovery *Sahelanthropus tchadensis* from Chad, currently considered the oldest hominid known to science

Glossary

(**Note**: For names of specific primates, please refer to the Species Sketches section.)

Acclimatization: A physiological process of adaptation, as to extreme climate, in either the short or long term.

Adaptive radiation: Rapid expansion of new animal forms into new habitats.

Anthropoids: One of the two major groupings of primates; the anthropoids are diverse, including all the monkeys, apes, extinct human ancestors, and modern humans.

Apes: A subset of anthropoids that tends to be large-bodied and includes humans' closest living relatives.

Biological anthropology: The subfield of anthropology that takes as its subject matter the evolution, genetics, and anatomy of, and modern variation within, the human species.

Conceptual model: Model that focuses on evolutionary processes rather than specific organisms in trying to understand the behavior of extinct human ancestors.

Differential reproductive success: Refers to the fact that within a population, some individuals will produce more healthy offspring than others.

Evolution: Change in the genetic structure of a population.

Gene: A sequence of DNA that can be passed on to offspring.

Gene flow: One of the major mechanisms of evolution; refers to the exchange of genes between populations.

Gene pool: All the genes shared by members of a single population.

Genetic drift: One of the major mechanisms of evolution; occurs in small populations when random events shift the composition of the gene pool.

Gracile: Relatively light-boned and slender.

Hominids: Primates, including those that led to modern humans, characterized by bipedalism; evolved after the evolutionary split with the great apes.

Homology: A similarity based on shared descent (if two primates have homologous traits, the traits are alike owing to a common evolutionary heritage).

Iconic gesture: Gesture that indicates the specific action that the gesturer wishes another animal or person to take.

Intelligent design: A set of beliefs predicated on the idea that some organs and organisms, such as humans, are so complex that they could have arisen only by design (not by unguided evolutionary mechanisms).

Matriline: A group of related females.

Mitochondrial DNA (mtDNA): Inherited only through the maternal line and, thus, changed only via mutation, mtDNA is a possible tool for tracing descent lines in prehistory.

Monkeys: A diverse set of anthropoids that are relatively small-bodied, more distantly related to humans than are the apes.

Multiregional model*:* One of two major models for the origins of modern humans; this one suggests that *Homo sapiens* evolved from earlier hominids on three continents at about the same time in response to regional selection pressures.

Mutation: One of the major mechanisms of evolution; refers to a change in the structure of DNA within a gene.

Natural selection: The single most important mechanism of evolution; refers to the fact that some individuals within any population will be better adapted to their local environment than others, leading to greater reproductive success.

Out-of-Africa replacement model: One of two major models for the origins of modern humans; this one suggests that *Homo sapiens* evolved first in Africa, then spread out to other areas and replaced all other hominids.

Patriline: A group of related males.

Phylogenetic model: Model that proposes taking into account the behavior of all four great apes in trying to understand an extinct human ancestor.

Population: Members of a species that share a common gene pool and mate more with one another than with members of other populations.

Primates: Division of mammals that includes all prosimians, monkeys, apes, extinct human ancestors, and modern humans.

Prosimians: One of the two major groupings of primates; the prosimians evolved first and are relatively specialized.

Punctuated equilibrium: The idea that evolution may sometimes proceed in rapid leaps rather than always by small, gradual modifications.

Race: A term used to suggest that humans can be sorted into distinct groups based on genetic traits, such as skin color or nose shape. Almost all biological anthropologists agree that this term has no biological validity.

Referential model: Model that proposes a 1:1 relationship between the behavior of some living primate and an extinct human ancestor.

Robust: Heavy-boned and strong.

Scientific creationism: A set of beliefs predicated on the ideas that the Earth is young and humans were created by a supernatural force within the last 10,000 years.

Sexual dimorphism: Anatomical differences based on one's sex.

Speciation: The process by which new species are formed from existing ones.

Species: A grouping of organisms whose members can all interbreed with one another and produce fertile offspring. The species is a larger grouping than the population.

Theory: In science, a set of principles that has been supported by observation and testing.

Theory of mind: The ability to take into account the mental perspective of another.

Species Sketches

Australopithecus afarensis: A gracile hominid species that includes "Lucy" and lived in Africa from about 3.6 to 3 million years ago.

Australopithecus africanus: The first australopithecine to be discovered, this gracile African form lived from perhaps 3.6 to about 2 million years ago.

Australopithecus anamensis: An African hominid dating to about 4.2 million years ago.

Australopithecus robustus and ***Australopithecus boisei***: Two robust hominids that lived in Africa along with gracile forms but eventually went extinct, apparently due to dietary overspecialization.

Bonobo: One of the African great apes; lives in bisexual communities with greater emphasis on female-female bonds than is found in the chimpanzees.

Chimpanzee: One of the African great apes; lives in bisexual communities with greater emphasis on male dominance than is found in the bonobos.

Gelada baboon: An Old World monkey that lives in one-male units; females bond with one another to prevent domination by males.

Gorilla: One of the African great apes; lives in either one- or two-male groups.

Great apes: Humans' closest living relatives, these large-bodied and large-brained apes are the orangutan, gorilla, chimpanzee, and bonobo.

Hamadyras baboon: An Old World monkey that lives in one-male units; males dominate females, harassing and biting them.

Homo erectus: The first hominid to live in Asia as well as Africa, this species, which includes the "Nariokotome Boy," is thought of as a turning point in human evolution. Appearing at about 1.9 million years ago, its "endpoint" is hotly debated but may be about 400,000 years ago.

Homo habilis: The first hominid in our own genus, this species is famous for being the first (as far as we know!) to manufacture stone tools. It lived in Africa from about 2.4 to 1.9 million years ago.

Homo neandertalensis: See **Neandertal**, below.

Homo sapiens: Modern humans; us. Modern human anatomy developed at perhaps 125,000 to 100,000 years ago.

Kenyanthropus platyops: Flat-faced hominid of Kenya, discovered by Maeve Leakey, that existed at about 3.5 million years ago. This species thus overlapped in time with *Australopithecus afarensis*.

Lesser apes: Small-bodied apes of Asia, including gibbons, that usually live in monogamous pairs.

Marmoset: A small New World monkey that lives in extended family groups.

Muriqui: A relatively large New World monkey that lives in peaceable social groups largely devoid of relative ranking.

Neandertal: Hominid that is likely a separate species from modern humans but overlapped with them in time and place. The Neandertals lived in Asia and Europe from about 130,000 to 30,000 years ago.

Orangutan: The only Asian great ape and the least social of all apes.

Orrorin tugenensis: A very old African hominid, dated to about 5.8 million years ago; dethroned by *Sahelanthropus tchadensis* in 2002 as the "oldest known hominid."

Rhesus monkey: An Old World monkey organized into matrilines with great emphasis on dominance hierarchies.

Ring-tailed lemur: A group-living African prosimian in which females are routinely dominant to males.

Sahelanthropus tchadensis: Best current candidate for the oldest hominid, at about 7 million years ago; announced in 2002 by scientists working in Chad, central Africa.

Savanna baboon: An Old World monkey organized into matrilines and heavily dependent on dominance hierarchies.

Slow loris: A nocturnal Asian prosimian that is far more social than expected for such a primate.

Transitional hominid species: The catchall term we use to refer to those hominids that lived after ***Homo erectus*** but before ***Homo sapiens***, with a mix of *erectus-sapiens* traits. These hominids are found in Africa, Asia, and Europe.

Bibliography

Essential Reading:

De Waal, Frans. *Tree of Origin: What Primate Behavior Can Tell Us About Human Social Evolution.* Cambridge, MA: Harvard University Press, 2001. This edited collection, with contributed chapters from leading scholars, demonstrates beautifully the ways in which specific studies of monkeys and apes can shed light on our hominid ancestry.

Gould, Stephen Jay. *The Structure of Evolutionary Theory.* Cambridge, MA: The Belknap Press of Harvard University Press, 2002. Published just before his death, this volume is Gould's *magnum opus.* It explains how newer concepts can be integrated with Darwin's insights to produce a comprehensive vision for understanding evolution. At well over 1,000 pages, the volume is formidable, but selected chapters are well worth the effort for the serious student.

Johanson, Don, and Maitland Edey. *Lucy: The Beginnings of Humankind.* New York: Simon and Schuster, 1981. A fact-filled, enjoyable account of Lucy's discovery specifically and theories of human evolution generally, this book gives an excellent feel for what it is like to be a fossil hunter in Ethiopia. It must be read in the context of the course, however; some of its conclusions about Lucy's place in the human family tree have been overturned by newer information.

Jurmain, Robert, Harry Nelson, Lynn Kilgore, and Wenda Trevathan. *Introduction to Physical Anthropology,* 8th edition. Belmont, CA: Wadsworth Publishing, 2000. The text of choice for many biological anthropologists, this book provides vital background information on the topics covered in this course. It includes superb visuals (photographs, charts, diagrams). The chapters cited as essential reading at the end of each lecture are keyed to the 8th edition, but newer editions, when available, would be even better.

Keller, Evelyn Fox. *The Century of the Gene.* Cambridge, MA: Harvard University Press, 2000. Written elegantly and aimed at non-experts, this book examines what genes are and what they are not (and how that understanding has changed as new knowledge accumulates). Keller shows that we cannot understand genes as isolated units, but must instead, study them at work as part of a larger biological system.

King, Barbara J. *The Origins of Language: What Nonhuman Primates Can Tell Us.* Santa Fe, NM: School of American Research Press, 1999. Lecture Eighteen relies heavily on this volume's contribution by Burling, who creates a plausible scenario of the evolution of language from ape gesture. Other chapters are useful for understanding the evolutionary transition from nonhuman primate communication to human language.

Marks, Jonathan. *What It Means to Be 98% Chimpanzee: Apes, People, and Their Genes.* Berkeley, CA: University of California Press, 2002. Marks's title refers to the oft-cited statistic that humans and chimpanzees share 98% of their genes. But what does this really mean? In his typically engaging style, Marks examines not only this question but others related to human "race" and variations that spring from it.

Natural History, April 2002 issue. Two features in this issue explain in clear terms issues of relevance to this course. First is a series of short opinion pieces that together constitute a written debate between evolutionary theorists and intelligent design advocates. Second is the column by science writer Carl Zimmer on evolution of the eye.

Profet, Margie. *Pregnancy Sickness: Using Your Body's Natural Defenses to Protect Your Baby-to-Be.* Cambridge, MA. Perseus, 1997. A readable account of Profet's fascinating theory that pregnancy sickness is a long-ago evolved adaptation to protect the developing fetus.

Scientific American, July 2002 issue. The no-holds-barred title of John Rennie's article says it all; "15 Answers to Creationist Nonsense" refutes myths and misunderstandings related to basic concepts in evolutionary theory.

Somer, Elizabeth. *The Origin Diet: How Eating Like Our Stone Age Ancestors Will Maximize Your Health.* New York: Owl Books, 2002. As a registered dietician, Somer does an intriguing job of suggesting ways in which knowledge of paleonutrition might improve our lives today.

Sykes, Bryan. *The Seven Daughters of Eve: The Science That Reveals Our Genetic Ancestry.* New York: W.W. Norton and Co., 2001. Genetics professor Sykes writes about the uses to which mitochondrial DNA may be put in clarifying issues in human evolution. He tackles controversies, such as how closely related Neandertals are to modern humans, and gives his perspective on the origins of modern *Homo sapiens.*

Tattersall, Ian. *The Last Neanderthal: The Rise, Success, and Mysterious Extinction of Our Closest Human Relatives*. Boulder, CO. Westview Press, 1999. A paleoanthropology curator at the American Museum of Natural History in New York, Tattersall has written a string of valuable books on human evolution. This one is particularly welcome for its illustrations that wonderfully bring to life the Neandertals.

Weiner, Jonathan. *The Beak of the Finch: A Story of Evolution in Our Time.* New York: Knopf, 1994. Reviewers have noted that this Pulitzer-Prize-winning account reads like a thriller! It details research done by the Grants, a husband-and-wife team of biologists that has carried out modern-day evolutionary studies on the finch populations in the Galapagos Islands—the descendant birds of those studied by Charles Darwin.

Supplementary Reading:

Behe, Michael. *Darwin's Black Box: The Biochemical Challenge to Evolution.* New York: Free Press, 1996. This book, billed by some as "a scientific argument for the existence of God," presents one case for an intelligent design perspective. It can be read as an alternative to the evolutionary thinking that is the foundation for this course.

Blakey, Michael. "Bioarchaeology of the African Diaspora in the Americas: Its Origins and Scope." *Annual Review of Anthropology* 30:387–422, 2001.

Cosmides, Lena, John Tooby, et al. *What Is Evolutionary Psychology: Explaining the New Science of the Mind.* New Haven, CT. Yale University Press (forthcoming in 2003). This book promises to be a lively and lucid account of the principles of the emerging field of evolutionary psychology.

Jolly, Alison. *Lucy's Legacy: Sex and Intelligence in Human Evolution.* Cambridge, MA: Harvard University Press, 1999. An always literate, sometimes amusing analysis of how issues of sex and gender figure into primate behavior and human evolution.

Potts, Richard. *Early Hominid Activities at Olduvai.* Aldine de Gruyter, 1988. The Smithsonian Institution's Potts lays out a fascinating behavioral framework for interpreting the hominid sites at Olduvai Gorge, Tanzania. Particularly enlightened is his alternative formulation to a long-accepted model of *Homo habilis* behavior.

Sapolsky, Robert. *A Primate's Memoir.* New York: Scribner, 2001. An informative and fun account by a distinguished primatologist, MacArthur "genius" award winner, and Teaching Company faculty member. He writes about his many years in Kenya studying wild baboon behavior.

Savage-Rumbaugh, E. S., and R. Lewin. *Kanzi: The Ape at the Brink of the Human Mind.* New York: Wiley, 1994. The accomplishments of the bonobo Kanzi, who can produce and comprehend symbolic utterances, are chronicled in this volume.

Biological Anthropology: An Evolutionary Perspective

Part II

Professor Barbara J. King

THE TEACHING COMPANY ®

Barbara J. King, Ph.D.

Professor of Anthropology, The College of William and Mary

Barbara J. King, a biological anthropologist, specializes in the study of primate behavior and human evolution. Since 1988, she has taught at The College of William and Mary and has won four teaching awards: the William and Mary Alumni Association Teaching Award, the College's Thomas Jefferson Teaching Award, the Virginia State Council of Higher Education's Outstanding Faculty Award, and the designation of University Professor for Teaching Excellence, 1999–2002.

Professor King's research interests center around the social communication of the great apes, the closest living relatives to humans. Currently, she and her students observe and film the gestural communication of gorillas living at the Smithsonian's National Zoological Park, in Washington, D.C. Funded by the Wenner-Gren Foundation for Anthropological Research, this research is the basis of her new book. Tentatively titled *The Dynamic Dance: Nonvocal Social Communication in the Great Apes*, this book will be completed during Professor King's year as a Guggenheim Foundation Fellow (academic year 2002–2003).

Other books authored or co-authored by Professor King reflect her longstanding interest in the "big issues" in anthropology. One such book, *The Information Continuum* (1994), is based on her doctoral research into baboon social learning in Kenya, and two others, edited volumes, resulted from major funded conferences in anthropology (*The Origins of Language*, 1999, and *Anthropology Beyond Culture*, co-edited with Richard Fox, 2002).

Professor King received her B.A. in anthropology from Douglass College, Rutgers University, and earned both her M.A. and Ph.D. in anthropology from the University of Oklahoma. At The College of William and Mary, she focuses on teaching primate studies and human evolution to undergraduates.

Professor King welcomes questions or comments at either of these addresses: Department of Anthropology, The College of William and Mary, Williamsburg, VA 23187-8795, or bjking@wm.edu.

Table of Contents

Biological Anthropology: An Evolutionary Perspective Part II

Acknowledgement:

Footage of a rhesus monkey on Cayo Santiago provided by Christy Hoffman.

Biological Anthropology: An Evolutionary Perspective

Scope:

These twenty-four lectures present detailed, up-to-date material about all aspects of the evolution of humanity. Aimed at those who are curious about our origins as a species, this course covers the wide range of topics in the discipline of biological anthropology. Biological anthropology takes as its goal a comprehensive exploration of the forces of both biology and culture that shaped human prehistory and continue to shape our lives today.

Following an introductory explanation of the various scientific approaches that together make up the field of biological anthropology, the initial lectures focus on evolution and its mechanisms. Important concepts, such as Darwin's principle of natural selection, are defined clearly, with real-life examples, and their significance is explained. What emerges from this section of the course is an understanding of why evolution and religious faith never need be opposed, whereas evolution and the theory of creationism are in direct conflict (with creationism rejected by scientists).

Applying these concepts to evolutionary history, Lectures Four through Eight explore the origins and behavior of the nonhuman primates. As primates ourselves, we humans share a 65-million-year evolutionary history with prosimians, monkeys, and apes. These lectures concentrate on primate behavior, showing how our own cognition, language, and kinship bonds developed out of the abilities present in these primate relatives. Particular emphasis is put on the great apes, such as chimpanzees, those animals closer to us genetically and behaviorally than any other.

The hominids, our extinct ancestors that walked upright, evolved from a common ancestor with the great apes nearly 7 million years ago. The anatomy and behavior of these species, ranging from the famous "Lucy," to the less well-known but equally important "Nariokotome Boy," to the cave-dwelling Neandertals, are profiled in Lectures Nine through Fifteen. These lectures highlight ways in which biology and culture intersect to allow for milestones to be reached in human prehistory.

Examples include the enlarged brain that allowed stone tools to be manufactured for the first time by hominids at 2.5 million years ago and the increasing cognitive skills and emotional ties that together led to deliberate burial of the dead by Neandertals at about 60,000 years ago. Two lectures deal with issues related to gender in prehistory, asking what we can know about the relative roles of females and males in hominid societies.

Lectures Sixteen through Eighteen are devoted to the origins of modern human anatomy, behavior, and language. Biological anthropologists have identified what they believe to be the oldest modern-human remains at about 125,000 years ago. For reasons made clear, it is unlikely that these earliest *Homo sapiens* could have evolved from Neandertals. From which hominids, then, did they arise? Was Africa the center of modern human origins, as it had been the center for early hominid evolution? We consider two competing models in evaluating these questions. One model points to Africa as the sole home of our species, whereas the other posits simultaneous evolution in Africa, Asia, and Europe.

Even more debated are the origins of modern human behavior and language. New evidence points to significant shifts in biological anthropologists' understanding of each of these topics. Sites in Africa tell us that symbolism, art, and finely crafted tools may not have first appeared at 35,000 years ago in Europe as long thought; evidence for a long evolutionary history for language is mounting as well.

The final five lectures consider modern human life in evolutionary perspective. A near-consensus conclusion in biological anthropology, that the practice of grouping humans into "races" based on supposedly genetic traits is invalid scientifically, forms the heart of Lecture Nineteen. Subsequent lectures explore ways in which evolution has tailored human anatomy and behavior, even today, to specific environmental pressures.

Also considered at length are fascinating new suggestions that modern health problems and aspects of modern health psychology have arisen as a direct result of conditions in human prehistory—conditions to which we were once adapted but no longer are. Pregnancy sickness and human mate choice are two case studies in this section.

The course concludes with a look at twenty-first century "gene discourse," in which undue power is given to genes and genetic research as panaceas for the future. An evolutionary perspective yields an understanding that the kinship we humans feel with other primate species (both living and extinct), as well as the tools we collectively have at our

disposal for solving conflicts and other problems, are based not on genetics. Rather, they stem from a dynamic interplay of biological and cultural factors at work in our long evolutionary history.

Lecture Thirteen

Who Were the Neandertals?

Scope: No hominids pique greater interest, or are more shrouded in mystery, than the Neandertals. Did the Neandertals resemble the shambling cavedwellers so beloved by fiction writers, B-movie makers, and cartoonists? Or were they, in fact, relatively advanced, well-adapted primates, more like humans in many ways than like early hominids?

Biological anthropologists favor the second view. Neandertals were large-brained, bipedal walkers. Neandertals were significantly more stocky and muscled than are modern humans, however, with a very differently shaped skull.

Neandertal behavior is by no means primitive. These hominids made significant technological advances, hunted big game successfully, and even buried their dead—an act not associated with *Homo erectus*. The latest anthropological interpretations emphasize these advances while noting that bands of Neandertals were likely not as efficient in survival skills as were groups of modern humans.

As we will see, no consensus exists about the precise nature of the relatedness either between Neandertals and modern humans or among the other hominid species at this general time period. The interval between the latter *Homo erectus* time period and the disappearance of the Neandertals at approximately 30,000 years ago is currently a challenging one in paleoanthropology.

Outline

I. The Neandertals have been known to science since 1856 and, in that century and a half, have become a kind of cultural icon.

- **A.** Say "Neandertal," and the image that pops into many people's minds is that of an ancient, stooped, and not-so-clever "caveman" wearing animal skins. Asserting that someone today "thinks like a Neandertal" is far from a compliment.
- **B.** Historically, we can explain the source of this image. In 1911, a French anatomist reconstructed a Neandertal skeleton to represent just such a shambling, unintelligent creature.
  - **1.** The anatomist, like most others of his day, had a preconceived notion of what "ancient man" should look and act like.
  - **2.** He chose for reconstruction a skeleton whose bones were affected by arthritis, thus strengthening his conclusion that this hominid was far from modern in appearance.

II. Biological anthropologists now reject the "stooped caveman" reconstruction of Neandertals. Like other hominids, Neandertals were bipedal and show a mix of both more and less humanlike traits.

- **A.** Neandertals were large-brained hominids and walked bipedally with a modern gait.
- **B.** Neandertals were short, stocky, and extremely strong. This is one way in which they were markedly different in appearance from modern humans.
- **C.** From the neck up, Neandertals, despite their large brains, had a more primitive look than do modern humans. The Neandertal skull, with its low forehead, large brow ridges, and enlarged nasal area, is distinctive.

III. The best way to think of the Neandertals is as an archaic species closely related to modern humans but different enough to be classified in its own species, *Homo neandertalensis.*

- **A.** Precursors to Neandertal features can be traced in fossils as far back as 300,000 years ago.
- **B.** Most biological anthropologists refer to Neandertals as living between 130,000 to 30,000 years ago, with emphasis on the period of the last glaciation, starting at 75,000 years ago. Neandertals lived in Europe and Asia.
- **C.** Neandertals are different enough from *Homo sapiens* to warrant their own species. As we will see later, the two species did overlap in time and space.

IV. Behavior and culture of the Neandertals give intriguing hints that Neandertals were, in fact, complex thinkers. Biological anthropologists, however, disagree on how like modern humans they were in this regard.

A. The trend toward improved hominid technology over time continues with the Neandertals. Neandertal tools are based on flake manufacture.

B. Neandertals did sometimes live in caves and were successful hunters, proving that even oversimplified stereotypes do contain some truth! Some biological anthropologists suggest that their foraging patterns were more restricted and simplified than those of modern humans.

C. The area of interpretation about Neandertals that is subject to the most contention involves their cultural behavior.

1. Deliberate burial of the dead by Neandertals is accepted by most scholars. Burials at a cave in Shanidar, Iraq, offer a good case study. Do these and other Neandertal burials involve some kind of symbolism? Here, little agreement exists.

2. Can we find glimmers of early art among Neandertals? Biological anthropologists are skeptical.

V. The precise relationship of Neandertals to modern humans, and to other hominids of the same general time period, is unclear.

A. In these lectures, Neandertals are considered to belong to a separate species than modern humans. The Jurmain textbook recommended for this course, however, concludes that Neandertals are an archaic variant of our own species.

B. Analysis of ancient DNA may eventually reconcile this issue. At present, DNA analysis tends to support the view that Neandertals were a distinct species, but uncertainties surround this technique.

C. The time period directly before Neandertals appeared, that is, between 400,000 and 130,000 years ago, is best thought of as a transitional one. Several types of hominids may be present. Scientists are at work attempting to clarify the relationship of these species to both the earlier *Homo erectus* and the latter *Homo sapiens.*

D. In sum, Neandertal anatomy has come clearly into focus in recent decades, and we learn more about Neandertal behavior by the year. Yet the ancestral relationships among Neandertals, modern humans, and other hominids in this general time period remain fuzzy.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 12.

Tattersall, *The Last Neanderthal*.

Questions to Consider:

1. State some significant ways in which Neandertals differ from *Homo erectus*. Consider both anatomy and behavior.

2. What are three possible interpretations for why Neandertals deliberately buried their dead? Are some of these interpretations more cognitively impressive than others?

Lecture Fourteen

Did Hunting Make Us Human?

Scope: In several previous lectures, we have noted that early *Homo* ate meat, obtaining it by processing animal carcasses with stone tools. But when did hominids turn from scavenging and opportunistic capture of small game to organized big-game hunting? Was hunting a "prime mover" of increased hominid brain size, as envisioned in classic early anthropological models?

In the late 1960s, two male anthropologists published a paper that was to remain influential for many years. This "Man the Hunter" paper claimed that hominid hunting, specifically the male-male cooperation seen as the heart of hunting, brought about great leaps in hominid problem solving and intelligence. The story of human evolution, in this view, was equated with the story of hunting.

Before long, some female anthropologists objected. What about the role of women in hominid food procurement, they asked? Female gathering of plant and vegetable material was likely far more crucial than hunting, they wrote, in bringing about increased intelligence and promoting the cohesion of social groups.

More recently, some anthropologists have challenged the hunting scenario from another quarter. They argue that hunting, as opposed to scavenging, developed too late in human evolution to have acted as a prime mover. A key question here is whether *Homo erectus* was primarily a scavenger or a hunter.

Although the "Man the Hunter" scenario in its starkest form has been rejected, echoes of the debate surrounding it may still be heard today. The biological anthropologist Craig Stanford has recently resurrected the role of meat-eating and meat-exchange as a prime mover in the story of human evolution. Taking a look at these various arguments, we will assess the degree to which hunting is a fundamental human adaptation.

Outline

I. We have seen that *Homo habilis* processed animal carcasses with Oldowan tools, and *Homo erectus* ate even more meat. We have remained agnostic, however, on the question of how this meat was procured, other than to suggest a role for scavenging. Several classic anthropological models have debated directly whether hunting was a prime mover in human evolution.

- **A.** In the 1960s, Sherwood Washburn co-authored a seminal article with fellow anthropologist Chet Lancaster, claiming in no uncertain terms that hunting made humans human.
  - **1.** Males are naturally drawn to hunting, these authors wrote. The skills of intelligence and cooperation required to bring off a successful hunt shaped the evolution of our species.
  - **2.** In this scenario, females were painted as passive creatures who evolved on the "coattails" of the hunting males.
  - **3.** Modern hunter-gatherer peoples were a referent for this type of model, but selectively so; the role of modern male hunters was emphasized.
- **B.** Response to Washburn and Lancaster came from anthropologists writing in the 1970s, including Tanner and Zihlman, who believed that the female role in hominid evolution had been keenly undervalued.
  - **1.** Tanner and Zihlman, among others, suggested that the gathering activity of females—collecting plants, tubers, and nuts—would have been more reliable and important than male hunting in hominid evolution.
  - **2.** Using chimpanzees as referents, these female anthropologists argued that female hominids may have invented new tools to aid foraging in early human evolution. Thus, women would have been active, perhaps primary, contributors to the evolution of hominid intelligence and social cohesion.
  - **3.** Ironically, Washburn and Lancaster's male-hunting model coincided with the publication of anthropological data showing that it is women's gathering activity that makes the major contribution to foraging in many hunter-gatherer peoples. These data supported Tanner and Zihlman.

II. In the next decades, the 1980s and 1990s, paleoanthropologists avidly sought hard evidence to shed light on the origins of human hunting. Early paleoanthropologists had been quick to equate any indicator of meat-eating with hunting. Paleoanthropologists were now more cautious.

A. Scavenging is an obvious alternative method for obtaining meat. Because hominid scavenging leaves marks on bones that look distinct from hunting marks, scientists can sometimes distinguish the two foraging strategies.

B. No hard evidence supports hunting in any australopithecine or in *Homo habilis*, though scavenging is indicated for *Homo habilis.*

C. Debate still surrounds the role of hunting versus scavenging in later hominids, such as *Homo erectus* and the transitional forms between *Homo erectus* and *Homo sapiens.* The clearest case for hunting can be made at the site of La Cotte de Saint-Brelade on the Channel Island of Jersey, which is associated with a transitional form appearing after *Homo erectus.*

D. The relatively late appearance of organized big-game hunting, coupled with the existence of cooperative small-game hunting in wild chimpanzees, leads many biological anthropologists to exclude hunting as a prime mover factor in human evolution.

III. Very recently, the biological anthropologist Craig Stanford has reinvigorated the debate about the significance of hunting in human evolution. He once again suggests that hunting has been of critical importance in early hominid evolution, but he does so in a new way.

A. For many years, Stanford studied chimpanzees at Gombe, Tanzania, becoming impressed by their skills in hunting red colobus monkeys.

B. Stanford suggests that chimpanzees make an excellent referential model for the origins of meat-eating and hunting in human evolution.

C. He stresses, however, not so much the act of hunting itself as the food-sharing that results when male hominids get meat. The strategic use by males of meat as currency when interacting with females is the key factor.

D. Response to Stanford's model varies. Whereas he insists that his model avoids the passive female stereotyping so pervasive in Washburn and Lancaster's, other anthropologists are not so sure.

IV. Looking back at the history of hunting models, we see shifts over time; the importance accorded to male hunting waxed and waned over the decades. Certainly, some of these shifts were brought about by new paleoanthropological and primatological evidence. However, less concrete factors also play a role, as we will examine in the next lecture.

Essential Reading:

De Waal, *Tree of Origin,* chapter by Stanford.

Questions to Consider:

1. In what ways does the recent Stanford scenario differ from Washburn and Lancaster's original formulation about hunting? Are any similarities evident between the two?
2. Why do you think hunting has been far more popular as a prime mover in evolutionary theories than has scavenging?

Lecture Fifteen

The Prehistory of Gender

Scope: Biological anthropologists have hotly contested the relative roles of men and women in human prehistory, as the previous lecture on hunting versus gathering attests. From our current vantage point, it becomes clear that some important models of the evolution of human behavior were constrained by assumptions particular to American culture in the 1960s and 1970s. The nuclear family was, for instance, assumed to be the typical family structure in hominid evolution by some anthropologists; the male "producer" (food provider) was depicted as giving food and other aid to the female "reproducer" (breeder).

Such a simplistic scenario, we now see, does not fit with the cross-cultural data on human families. Neither does this scenario square with the evidence from primate studies showing that female monkeys and apes are capable of producing food for themselves and caring for their offspring without assistance from males. And if hominid females needed aid because their reproductive profiles differ from those of monkeys and apes, were males really the sole available source for that aid?

As assailable as male-dominated models, however, are scenarios of human evolution that depict females in control. No evolutionary validity is gained by transforming male-centered into female-centered models. The most credible schemes are those that emphasize flexibility in gender roles according to local resources and local environmental circumstances.

Outline

I. Paleoanthropological models by necessity involve interpretation (see Lecture Eight); the relatively sparse bones and artifacts of human evolution must be fleshed out. In turn, scientists' interpretations are shaped by the time and place in which they think and write. This may be especially true when it comes to interpretations of gender.

- **A.** Anatomical differences based on sex, that is, sexual dimorphism in male and female skeletons, may fossilize. It is often possible to distinguish skeletons by sex and to make inferences about different levels of strength, or variation in diet, between males and females.
- **B.** Behavioral differences based on sex do not fossilize. Few other clues exist as to which sex hunted, or cooked, or made tools—or whether both sexes may have carried out these activities. In the absence of hard evidence, paleoanthropologists turn to ethnographic evidence from living modern peoples.
- **C.** In selecting the data to use, and in combining different sources of data, subjectivity inevitably plays a role. An individual scientist's preconceptions about gender may creep into his or her model, perhaps unconsciously. As a quick example, we will analyze the museum diorama depicting two bipedal australopithecines leaving footprints in African ash more than 3.5 million years ago.

II. We will analyze in-depth three prominent paleoanthropological models, one already encountered and two new ones, that touch on gender roles. Our focus in each will involve the roles accorded to the hominid male and the nuclear family.

- **A.** As we have seen, Washburn and Lancaster's hunting model from 1968 gives to the hominid male the primary evolutionary role, deemphasizing the female's role. Significantly, it also projects the nuclear family millions of years back into the past.
- **B.** Thirteen years later, in 1981, Owen Lovejoy published a much-touted scenario in which the role of hunting was minimized. Males were still the evolutionary prime movers, though; mobile males were naturally selected to provision sedentary females and offspring. The nuclear family is as prominently placed in this model as in Washburn and Lancaster's.
- **C.** In 2001, Richard Wrangham and colleagues suggested that cooking food over a controlled fire outweighs hunting as a prime mover in human evolution. Females are active in this model because they are the ones who cook. Males, however, must protect females from potential theft of cooked resources by other "scrounger" males. Once again, the nuclear family reappears.
- **D.** All three models imply that hominid females would have pair-bonded with males because they require male protection to ensure their survival and reproductive success. How valid is this perspective?

1. Primate studies tell us that female primates are capable of both reproduction (of offspring) and production (of food for themselves); males do not provision females in monkeys and apes.
2. As life spans lengthened, however, hominid females would have become responsible for feeding their juveniles, as well as their infants. Hominid females may well have needed aid, then, to cope with an increased reproductive burden. Yet equating aid with male protection may be unnecessarily constraining.
3. Anthropologists have long known that the nuclear family is a minority pattern across the globe; it is now the minority pattern even in American society.
4. Gender patterns in American society may have influenced the models' authors in their willingness to draw conclusions about males and females in our distant past.

III. When anthropologists turn the tables on these male-dominant models and prioritize hominid females instead, rejecting the nuclear family in the process, no scientific validity is gained.

A. The models put forth by Tanner and Zihlman simply reverse the prevailing assumptions about gender. Females become more important evolutionarily than males, and female-centered networks are favored over the nuclear family.

B. Little support exists for models that privilege strict "behavioral sorting" by gender. Ethnographic data show that a variety of roles may be played by men and women and that a variety of social units may provide a society's base.

C. The best solution may be to offer alternative behavioral scenarios that all recognize the inherent variation within genders. Referential, phylogenetic, or conceptual models from primates; paleoanthropological evidence from skeletons and behavioral artifacts; and ethnographic analogies may all be used.

Essential Reading:

De Waal, *Tree of Origin,* chapter by Wrangham.

Supplementary Reading:

Jolly, *Lucy's Legacy*.

Questions to Consider:

1. What data support a shift in focus on hunting as prime mover to cooking as prime mover in human evolution?
2. What part can studies of monkeys and apes play in fashioning solid models of hominid gender roles?

Lecture Sixteen

Modern Human Anatomy and Behavior

Scope: A single question forms the core of this lecture: When and where did modern human anatomy and behavior appear? The fossil record points to development of modern human anatomy by about 125,000 years ago. Modern humanity, defined anatomically, is thus quite young in evolutionary terms.

The timing of modern human *behavior* is more contentious. An earlier view converged on a radical shift in behavior at about 35,000 years ago in Europe, with the appearance of new forms of technology; symbolic representations, including art; and advances in foraging and trading. Support for this view came from the famous "cave art" sites. The beautifully rendered animal representations on the walls at Lascaux Cave, France, have long been known. Newer data from the exciting 1994 discovery of Chauvet Cave, also in France, yield an even more complete picture of the art of early *Homo sapiens*.

Based largely on two exciting archaeological African sites, scholars are reassessing the idea that a revolution in behavior can be neatly pinpointed in time at one specific region. Sophisticated tools and art predating 35,000 years ago, and found in Africa rather than Europe, indicate that scientists need to take a more global view of the origins of modern human behavior.

Outline

I. Fully modern *Homo sapiens* differ in appearance from Neandertals and the so-called transitional forms that show a mix of *erectus-sapiens* traits.

- **A.** The most dramatic changes appear in the shape of the skull. Compared to Neandertals and transitional hominids, modern humans have a high forehead, smaller brow ridges, smaller teeth, and a definite chin.
- **B.** Variation can be still seen today in the modern human skull; a few populations show a more pronounced brow ridge than is the norm, for example.
- **C.** Post-cranially, modern humans have lighter, more slender bones than Neandertals and other hominids.

II. Modern human anatomy most likely first evolved in Africa at approximately 125,00 years ago.

- **A.** Three sites in Africa provide the most concrete evidence: Klasies River Mouth and Border Cave in South Africa, and Omo Kibish in Ethiopia. Dating of these sites, however, is not foolproof.
- **B.** Rival sites in the quest to identify the first modern human anatomy are found in the Middle East. Two cave sites in Israel, Qafzeh and Skuhl, are the most important but probably post-date slightly the African sites.
- **C.** Whether the African or Israeli sites turn out to be older, we can conclude that *Homo sapiens* is evolutionarily quite recent.

III. Identifying modern human behavior, and when and where it might first be found, is an order of magnitude more difficult than the search for the first modern anatomy.

- **A.** Typically, by the term *modern behavior*, biological anthropologists refer to a cluster of innovations relating to technology, art and other symbolic representation, and advances in foraging and trading.
- **B.** Biological anthropologists initially traced these behavioral innovations to Western Europe, suggesting that they appeared there at about 35,000 years ago. In this view, there was a great leap forward in human behavior in a single time and place.
    1. So-called Upper Paleolithic tools in Europe at this time show fine workmanship in wood, bone, and antler.
    2. Breathtaking examples of art, only seen after 30,000 years ago, have long been known from such caves as Lascaux in France. In 1994, Chauvet Cave was discovered, also in France, yielding amazing new clues to hominid art. Portable art is also associated with the Upper Paleolithic in Europe.
    3. These advances and others in hunting and long-distance exchange of objects look wholly different from anything produced by Neandertals, or other hominids, according to many scholars.
- **C.** Recently, evidence suggests that instead of a sudden behavioral revolution in Europe, modern human behavior may have appeared more gradually and in a more distributed way around the globe.

1. Although it seems clear that *Homo sapiens* is set apart from other hominids behaviorally, the early focus on a specific behavioral revolution may be, in part, the result of a Eurocentric bias. Africa may once again be implicated in some "firsts" in human evolution, as it has been so often.
2. New excavations at two African modern-human sites, Katanda in Zaire and Blombos Cave in South Africa, are forcing reevaluations of the appearance of sophisticated modern technology. Bone, for example, appears to be very finely worked at these sites. These sites significantly predate the supposed European behavioral revolution.
3. Rock art in Namibia and other places in Africa date to approximately the same time periods as the French caves.

IV. In sum, it appears that modern human anatomy evolved before the cluster of traits that we refer to as modern human behavior. However, the timing for appearance of modern human behavior has shifted appreciably in just the last few decades. The old idea that Africa was the home of early human evolution but that modern human behavior evolved in Europe is now suspect.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 13, second half.

Questions to Consider:

1. What questions would arise for paleoanthropology if the Israeli *Homo sapiens* sites are found to predate the sites in Africa?
2. Two sites excavated in the 1990s are significantly altering our understanding of the origins of modern human behavior. What are the main new findings at Chauvet Cave in France and Blombos Cave in South Africa?

Lecture Seventeen

On the Origins of *Homo sapiens*

Scope: We know that *Homo sapiens* is a young species, in evolutionary terms; we humans are no older than 125,000 years anatomically, with modern behavior appearing even more recently than that. But from which hominid populations did *Homo sapiens* evolve? And at what point did modern humans become the sole hominid on Earth?

Homo sapiens likely evolved from transitional hominid populations living between 400,000 and 200,000 years ago; by about 30,000 years ago, our species was the only hominid alive on Earth. Two major models try to explain modern human origins. Scientists who support the *Out-of-Africa replacement* model suggest that *Homo sapiens* developed first in Africa, then migrated out across the world, replacing all other hominid populations as they went. Those who support the rival *multiregional* model insist that *Homo sapiens* evolved locally on three continents, each regional population responding to local selection pressures.

Each model produces different predictions. To evaluate these differentially, three sources of information can be used. Hominid sites and specific fossils can be compared across regions of the world. Evolutionary theory allows assessment of more likely and less likely scenarios of evolutionary change. Finally, DNA can be analyzed to identify pathways of genetic changes over time.

At this point in the course, it is likely no surprise to learn that biological anthropologists can reach no consensus on which model to support. It is even possible that an intermediate sort of model, combining elements of both the Out-of-Africa and multiregional models, might be the best candidate for explaining modern human origins.

Outline

I. Modern humans originated no earlier than about 125,000 years ago. Between that time and 30,000 years ago, *Homo sapiens* shared the Earth with Neandertals. Could our species have evolved from Neandertals?

- **A.** Given that Neandertals and modern humans evolved at about the same time, it is unlikely that Neandertals gave rise to modern humans. Rather, we can think of the two species as co-inhabiting certain areas at certain times.
  - **1.** Neandertals and modern humans occupied the same general region of the Middle East between about 90,000 and 60,000 years ago. Biological anthropologists have no sense of whether the two species directly met.
  - **2.** Neandertals and modern humans not only occupied the same regions of Western Europe at about 40,000 years ago, but biological anthropologists are fairly sure that the two species met and competed for resources.
- **B.** Neandertals and modern humans may have both arisen from the same or similar earlier hominid populations, then adapted in different directions to different selection pressures.
  - **1.** A plausible hypothesis is that *Homo erectus* evolved into transitional hominids marked by a mix of *erectus-sapiens* characteristics. Populations lived in Africa, Asia, and Europe between 400,000 and 130,000 years ago.
  - **2.** Some populations evolved in the direction of modern *Homo sapiens*, whereas others did not.

II. The *Out-of-Africa replacement* hypothesis posits that all the evolutionary "action" in modern human origins occurred in Africa. Modern forms then spread out through the Old World, replacing all other hominid populations.

- **A.** Modern humans first evolved in Africa, as evidenced by the sites of Klasies River Mouth, Border Cave, and Omo.
- **B.** As hominids migrated north out of Africa, they encountered other hominid populations and replaced them but without interbreeding.

III. The *multiregional* hypothesis posits that evolution of modern humans occurred on three continents.

- **A.** Gradual evolution in Africa, Asia, and Europe accounts for the origins of modern humans in this perspective.
- **B.** Gene flow among populations on these three continents prevented speciation from occurring.
- **C.** Replacement of one hominid population by another did not occur; rather, *Homo erectus* and other hominids evolved locally and gradually into *Homo sapiens.*

IV. Multiple sources of evidence can be brought to bear in testing these two models.

- **A.** Precise dating of archaeological sites is crucial; if the African *Homo sapiens* sites are not, in fact, the earliest, then the Out-of-Africa position is weakened.
- **B.** Comparison of fossil anatomy from different regions produces a mixed picture.
  - **1.** In some regions, for example, in Asia, there seems to be clear evidence of local continuity. That is, certain features can be traced across long periods of time within a certain region (but not across regions). This fact supports the multiregional model.
  - **2.** On the other hand, a corollary of the multiregional model is that in Europe, Neandertals evolved into modern humans. As we have seen, this situation seems unlikely.
- **C.** At least one reading of evolutionary theory appears to support the Out-of-Africa model. Stephen Jay Gould says that the multiregional model is very unlikely because it requires disparate populations to evolve in the same direction, despite variant local selection pressures.
- **D.** Out-of-Africa theorists have claimed that DNA analysis supports their case. A variety of methods have been attempted, most famously the one involving "mitochondrial Eve."
  - **1.** Mitochondrial DNA (mtDNA) is a subtype of DNA inherited only through the maternal line. Changes in mtDNA come about only through mutation and, thus, can be used to trace ancestry.
  - **2.** A study of modern variation in women's mtDNA showed that the greatest variation exists in Africa, implying that African people evolved first. It was even deduced that the first African, the so-called mitochondrial Eve, lived in Africa at about 200,000 years ago.
  - **3.** Subsequent genetic tests cast doubts on the precise methods used to reach the conclusion about mitochondrial Eve. In any case, skeptics, especially those who espouse the multiregional model, say it is misleading to imply that one specific modern human female was the mother of us all.

V. A possible solution in the stalemate between the two models of modern human origins is to embrace an intermediate model, which is called the *partial replacement model*.

- **A.** In this third model, *Homo sapiens* did migrate north from Africa, where they first originated.
- **B.** Along the way, these individuals hybridized to some degree with local hominid populations. Replacement, thus, occurred gradually.

VI. Returning to a familiar refrain, we can sum up by saying that biological anthropology has produced good, solid, testable models about the nature of modern human origins; we now await more data to differentiate among them.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 13, first half.

Sykes, *The Seven Daughters of Eve.*

Questions to Consider:

1. What evidence do you believe would be most helpful in nailing down either the Out-of-Africa or multiregional model?
2. Why is mtDNA more useful in tracing ancient ancestries than is regular (nuclear) DNA?

Lecture Eighteen

Language

Scope: We humans can hardly imagine our daily lives without being able to express our ideas verbally (or through signed languages). Language underpins our most human experiences, from watching the performance of a Shakespearean play to exchanging news of our experiences at work, home, or school with loved ones at the end of a day. Language is the keystone of human culture. Biological anthropologists are, thus, keenly interested in finding out whether it is a trait unique to modern humans or has a longer evolutionary history.

The dominant view in linguistics, philosophy, cultural anthropology, and related disciplines tends to be that language is indeed confined entirely to our own species. In this view, production and comprehension of syntax or complex grammatical patterns must be evident before any sort of communication can be defined as language.

Another view posits that language developed gradually within the hominid lineage. Hominid anatomy, hominid behavior, and evolutionary reconstructions may all be marshaled in favor of this gradualist viewpoint. Some biological anthropologists extend this continuity perspective even farther, pointing out that monkey and ape communication includes elements of language.

Inarguably, some aspects of human language are unprecedented in the primate world. Humans have vast vocabularies with which to discuss not only the present, but also the past and future, sometimes using complex narratives. We will explore, using one reasonable (if speculative) model, how such abilities might have evolved.

Outline

I. Language involves far more than just conveying information; we humans experience and even construct our lives through language.

- **A.** Language is the basis for human sociality. Whether vocal or signed, language shapes our world.
- **B.** Language is such a fundamental part of the human adaptation that we routinely engage in "conversation" with infants, pets, and computers.
- **C.** Children learn immensely complicated languages with little apparent effort. How this process is accomplished is fiercely debated; for our purposes, we should note that even the youngest infants live in a linguistic world.

II. Three distinct possibilities can be envisioned in biological anthropology for how this fundamental human adaptation might have come about. Each is tied to a different understanding of the definition of language.

- **A.** Language is unique to modern humans and of recent evolutionary origin.
  1. The complex grammatical patterns of syntax are the key element of language; without them, language cannot exist.
  2. Only the modern human brain is capable of generating and comprehending syntactical utterances. Thus, only modern humans can possibly have language.
  3. Significant discontinuity exists between human language and all other forms of hominid, as well as animal, communication.
- **B.** Language is unique to the hominid lineage but not unique to modern humans; early *Homo* might have had, and certainly Neandertals and later transitional forms did have, language.
  1. Language should not be equated with syntax. We cannot know when syntax evolved, but a broader view of language is more compatible with an evolutionary perspective.
  2. Both anatomical and behavioral clues point to hominids as capable of language. These clues range from the position of various organs in the hominid vocal tract, to details of hominid brain anatomy, to known hominid behaviors that would have required some linguistic capability to perform.
  3. Significant continuity exists across hominids, and between early and later forms of *Homo*, but significant discontinuity exists between hominid language and all other forms of animal communication.

C. Language, or significant elements of language, can be found in primates even before the evolutionary split between hominids and great apes.

1. An evolutionary perspective compels us to understand that language emerged gradually, with no major Rubicon crossed at the starting point of the hominid lineage. We may view language either as composed of various critical components or as complex communication that results in cohesive social groupings.
2. Either of these definitions of language allows us to find language in monkeys and apes today. Some wild monkey populations, together with the enculturated apes, offer the best illustrations.
3. Complex nonhuman primate communication is related to human language by homology; the relationship between the two is unlike that between communication of primates and of all other animals, even, for instance, dolphins.

III. The human species-specific form of language is without a doubt different, even if only by degree and not by kind, from all other communication systems. Viable step-by-step evolutionary scenarios exist for a gradual development of this human adaptation.

A. Only human language relies on large vocabularies comprised of words with specific, widely understood meanings. These words are used in ways that not only convey information in the present, but reflect on the past and plan for the future.

B. The emergence of these special abilities need not be thought of as mysterious or wholly disconnected from evolutionarily prior systems of communication. A scenario proposed by the anthropologist Robbins Burling includes key steps that might explain the necessary evolutionary shifts.

1. The evolutionary base is provided by the iconic gesturing of great apes (see Lecture Seven).
2. With increased brain size and an increased ability over that of the great apes to imitate actions of others, hominids would have been better able to adopt utterances made by social companions and use them in a socially conventional way. The need for reliance on iconic signs would have decreased.
3. Over time, linguistic signs would become more and more arbitrary—breaking the link between a sign and its referent. Words could begin to refer to specific objects, events, or actions.
4. Eventually, using words in orderly combinations would have become more and more beneficial, leading to the development of syntax.
5. Burling clearly admits this scenario is speculative, but it does dovetail nicely with data from primate studies, as well as with evolutionary logic.
6. As with all other hypothetical scenarios that we have reviewed, this one both requires more data and stimulates more research. The creation of plausible scenarios is an important part of the ongoing work in biological anthropology today.

Essential Reading:

King, *The Origins of Language,* especially chapter by Burling (second half) and King's chapter 2.

Questions to Consider:

1. Which of the three views of language do you find most convincing? Why?
2. What specific type of hominid discovery do you think would most help clarify the origins of language?

Lecture Nineteen

Do Human Races Exist?

Scope: In the final lectures, we shift gears again to consider ways in which biological anthropology explicitly interacts with issues in today's modern world. We start with a question that may be a surprising one: Do human races exist?

Contemporary biological anthropologists have achieved a near-consensus in answering this question: No matter how sociologically useful the concept of race may be, there is no biological validity to the idea that human races exist. Whichever way one tries to carve up the human species into discrete races—based on skin color and other genetic attributes—it turns out that there is too much variability *within* each race for the idea to have any biological meaning. The human species is too recent in origin, and too characterized by gene flow and mating between groups, for meaningful biological differences to evolve.

Yet a few prominent scholars refuse to accept the view that race is a biologically invalid concept. They ask us to open our eyes. Races, they say, are immediately distinguishable by the person on the street; why, then, can't biological anthropologists accept reality? Don't race-specific anatomies, behaviors, and diseases exist? Confronting this type of query head on, we will work to understand why it is based on scientifically inadequate thinking about race.

Outline

I. The final section of the course explores topics in biological anthropology that relate to contemporary human populations. We begin with a vexing one: Can the human species be understood as made up of biologically distinct races?

- **A.** The term *race* is so ingrained in American society that the very question we are asking may take people aback.
  - **1.** As the biological anthropologist Michael Blakey has said, the idea that people can be grouped into races may seem as obvious to us as the sun rising in the east every morning.
  - **2.** Since at least the time of Linnaeus, the eighteenth century Swedish biologist, we have been presented with taxonomies of the human races, and the concept has become second nature.
  - **3.** Yet we know that science pushes us to investigate phenomena that are seemingly obvious and to insist on questioning their validity. (After all, the sun doesn't really rise in the sky; this was Blakey's point.)
- **B.** We wish to explore race only from the perspective of biological anthropology.
  - **1.** Biologically speaking, a race would represent a group of people sharing genetically determined traits, such as skin color, hair color, eye shape, and nose shape, among others.
  - **2.** A race, then, would be an intermediate-level grouping of humans, in between that of the population and that of the species.
  - **3.** The sociological and historical validity of race, unlike the biological validity, are not at issue here.

II. Most biological anthropologists today reject the idea that the concept of human race has any biological validity. Race is a socially constructed concept.

- **A.** No agreement exists on how many races can be identified in the world. The possibilities range from 3 to more than 200, based on which traits one deems significant.
- **B.** No such entity as a pure human race exists in the world today; the world's populations constantly intermarry and interbreed.
- **C.** Further, to the best of anthropological knowledge, no such entity as a pure human race ever existed. Gene flow, migration, and interbreeding across populations are all processes with very long histories in the development of our species.
- **D.** Today, more variation exists within so-called races than between them. The best estimate suggests that only 15% of all human genetic variation can be traced to differences between races.

E. History shows us that race is used in socially constructed ways that are divorced from biological reality. The definition of what kind of person "counts" as a member of a certain race changes with historical context.

III. A few scientists today insist that the majority view is wrong. These scientists can be grouped into two camps, one from biological anthropology generally and another from forensic anthropology. They say that racial differences are both obvious and real.

- **A.** According to a few biological anthropologists, obvious evidence exists for the fact of human races.
  - **1.** Compare a man native to Stockholm, Sweden, with one from Dar es Salaam, Tanzania. The obvious differences one sees reflect human biology and race.
  - **2.** *Cluster diseases*, such as sickle cell anemia, much more prevalent in some races than others, cannot be ignored.
  - **3.** Occasionally, these notions extend to claims that different levels of intelligence can be found among different human races.
- **B.** The problem with these views is not that they are politically incorrect. Rather, they reflect poor (and outdated) evolutionary thinking.
  - **1.** The "Stockholm versus Dar es Salaam" test is flawed, in part because it ignores the gradual shifts in populations between these two geographic extremes.
  - **2.** When measuring such factors as disease or intelligence between groups, we must not forget that the groups are not now, and have never been, distinct from each other in the first place. So-called biological differences diminish or disappear when this fact is realized and when overlap between groups is recognized.
- **C.** In the area of applied biological anthropology, forensic anthropologists routinely classify individuals (from their skeletal remains) using the variable of race.
  - **1.** Forensic anthropologists, in analyzing bones, attempt to discern not only an individual's sex and age but also his or her race.
  - **2.** These scientists insist that using such categories as Caucasian-American, African-American, Asian-American, Hispanic, and native American is reliable and beneficial.
  - **3.** Most biological anthropologists reply that such classification has limited use. Providing information about race may help in legal matters but tells us little that is valid or genuinely interesting about the individual in question.
- **D.** The New York African Burial Ground Project shows how biological anthropologists can work with skeletal remains to go well beyond a focus on racial traits.
  - **1.** Project scientists have analyzed more than 400 skeletons from enslaved individuals who died and were buried in Manhattan during the seventeenth and eighteenth centuries.
  - **2.** The project's focus has been to explore the culture and history of an important human population.

IV. Human variation is a fascinating topic, one deserving of study by biological anthropologists. Trying to approach it by way of racial variation is inaccurate, but other avenues are available, and we turn to these in the next lecture.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 15, pp. 410–20 and 437–38.

Marks, *What It Means to Be 98% Chimpanzee,* chapters 4–7.

Supplementary Reading:

Blakey, "Bioarchaeology of the African Diaspora in the Americas."

Questions to Consider:

1. Of what significance to the discussion of race is the long human history of gene flow, migration, and intergroup mating?
2. From the perspective of biological anthropology, what is wrong with a statement such as "Asian-Americans are more intelligent than European-Americans?"

Lecture Twenty

Modern Human Variation

Scope: Though they reject the idea of human races, biological anthropologists remain very interested in how human populations vary in the modern world. As we saw in the last lecture, it is possible to glean much useful information about human variation by shifting the focus from individual or “racial” traits to analysis of whole populations.

We will consider two types of case studies of human variation. In the first, variation is studied in basic human features according to environmental variables. For instance, evidence suggests that individuals of the early hominid lineage originated in Africa with darkly pigmented skin. Lightening of skin color likely occurred only with the first Out-of-Africa hominid migrations north to areas of less intense sunlight. Variation in body shape has also been naturally selected in predictable and interesting ways.

Second, in working out how humans have adapted to extreme environments—to high altitude, for instance—biological anthropologists weigh the relative contributions of genetic adaptation, acclimatization, and cultural adaptation. We will differentiate and discuss these processes.

Research areas such as these allow biological anthropologists to study modern human variation in vital ways that reflect the human evolutionary past and free this field of study from its past obsession with human races.

Outline

I. Biological anthropologists embrace the study of human variation through study at the population level. We have come full circle back to Lecture Two, in which the population concept was introduced; now we can relate that concept to contemporary human life.

II. Skin color, when linked to the issue of race, is overemphasized in the study of human variation. Yet when approached populationally, skin color provides an excellent example of natural selection at work.

- **A.** One’s skin color comes about through the interplay of several biological substances, including the pigment melanin. Melanin acts to absorb ultraviolet (UV) light.
- **B.** Using melanin as a key, we can understand the origins of variation in skin color.
  - **1.** Originating in Africa, the earliest hominids likely had dark skin, to block dangerous levels of UV light. We can see UV light as a selection pressure on early hominid populations.
  - **2.** When *Homo erectus* migrated north out of tropical Africa, this selection pressure for dark skin would have relaxed.
  - **3.** A different selection pressure would have emerged in these northern hominid populations, the need for enough vitamin D, which is synthesized by sunlight striking the skin. A combination of dark skin and little light would have been costly to northern hominids.
- **C.** The maintenance of variation in human skin color is a biocultural phenomenon. Social patterns (of marriage, for example) are as important as biological selection pressures in the present day.

III. Just as human populations differ in predictable ways by skin color, so do they differ by body and limb shape.

- **A.** Populations that inhabit tropical areas tend toward having long, slender bodies and limbs. This body configuration is optimal for heat dissipation.
- **B.** Populations that inhabit colder areas tend toward having short, stocky bodies and limbs. This body configuration is optimal for heat retention.
- **C.** The words “tend toward” in A and B above are chosen with care; not all human populations conform to these expectations.

IV. Some humans live in areas where they must adapt to extreme climates. Study of high altitude, for example, allows biological anthropologists to distinguish separate but closely intertwined processes of human adaptation.

- **A.** Anyone who has traveled to high altitude is likely to recall the biological stresses of this extreme climate. Reduction in available oxygen may cause the new arrival to experience shortness of breath, dizziness, and other symptoms.
- **B.** Anthropologically, high altitude is defined as above 10,000 feet. Human populations that reside at high altitude face significant stressors, including higher rates of miscarriage and infant mortality than at lower elevations.
- **C.** Biological anthropologists have identified several different processes that allow humans to adapt to extreme altitude, in both the long term and short term.
  1. Some populations with thousands of years of cultural history at high altitude appear to have genetic advantages, because their reproductive success seems undiminished by their residence in such extreme climate.
  2. Individuals native to high altitude are born with larger hearts and greater lung capacity than those native to lower elevations. They undergo a type of acclimatization process during maturation, in which they become very efficient at using oxygen in the body.
  3. Immigrants or visitors to high altitude undergo a short-term variant of acclimatization, in which they gradually adapt to altitude stressors, and the unpleasant symptoms felt upon arrival diminish.
  4. Cultural adaptations, such as clothing, shelter, and traditions related to birth practices, may all aid the process of adaptation to high altitude.

V. Human adaptation to extreme heat appears to come somewhat more naturally to our species than does adaptation to extreme altitude.

- **A.** As we have seen, some human populations are characterized by skin color, body shape, and limb shape designed by natural selection for maximal adaptation to the heat of the tropics.
- **B.** All human populations, however, have evolved significant capacity to cope with heat relatively rapidly and efficiently by sweating.
- **C.** Heat adaptations in contemporary *Homo sapiens* reflect our long history as tropical primates.

Essential Reading:
Jurmain et al., *Introduction to Physical Anthropology*, chapter 15, pp. 420–36.

Questions to Consider:

1. How does the fact of our African origins help us understand the phenomenon of human skin color variation?
2. In what ways does individual acclimatization to high altitude differ from the genetic adaptation characteristic of some native populations?

Lecture Twenty-One
Body Fat, Diet, and Obesity

Scope: Another avenue biological anthropologists may use in studying modern human variation involves comparing and contrasting the adaptations of males and females. Many people would guess that the greatest difference between the sexes is to be found in height or weight. In fact, the single most pronounced feature of sexual dimorphism relates to the distribution of fat on the body.

Sexual dimorphism in fat deposition makes good evolutionary sense. Female fat is typically located in specific areas where it can buffer the body against periodic food shortages. We can understand the evolution of this link between fat and reproductive success by thinking about the conditions of our evolutionary past.

Yet what we see in many countries is not just a predictable pattern of sexually dimorphic fat deposition. We find also a virtual epidemic of obesity among men, women, and children. What has happened here? Examining the evolutionary history of human diet yields some clues. For many people in the world, access to foods that were previously in quite short supply is now rather easy. The human body cannot always cope in a healthy manner with such abundance.

Considering body fat, diet, and obesity in evolutionary perspective illustrates the interplay between biology and culture in modern society. Practical solutions for healthier living may emerge from this consideration.

Outline

I. Modern human variation occurs within as well as between populations. One significant source of such variation is sex; male and female humans show aspects of sexual dimorphism.

- **A.** *Sexual dimorphism* is defined as differences in physical traits between males and females of the same species.
- **B.** In humans, compared to many other primates, males and females show minimal sexual dimorphism in height and weight.
- **C.** The way in which sexual dimorphism is most pronounced in humans involves the distribution of body fat.
  - **1.** Body fat tends to cluster around the hips, buttocks, and breasts in females. These are the so-called "reproductive areas" of the female body.
  - **2.** Body fat for males, by contrast, tends to cluster around the stomach.

II. Reasons for the sexually dimorphic nature of fat deposition may be found in the link between fat and reproductive success in human evolutionary history.

- **A.** Fat acts as a buffer in the human body against reduced caloric intake. Should food become scarce, the body begins to metabolize its fat to prevent malnutrition or starvation.
- **B.** Food shortages, whether seasonal or periodic, are a likely fact of ancestral hominid life. All humans, until 10,000 years ago, lived off the land (gathering, scavenging, and/or hunting); animal domestication and agriculture developed later in human history.
- **C.** Hominid females with "fat buffers" in so-called reproductive areas of the body were likely able to withstand caloric reduction during food shortages better than females without such buffers. Fat reserves would have been selected for in this context.

III. The increasing rate of obesity in the United States can be seen as stemming from an ancestral adaptation that has gone seriously awry in our modern environment.

- **A.** According to figures released by the Centers for Disease Control in 2002, 27% of adults and 15% of children in the United States are obese.
- **B.** This obesity is evolutionarily recent. In the hominid past, food shortages would have combined with a perennial scarcity of salt, sugar, and fat. It was virtually impossible for anyone to ingest too much of these three substances.

- **C.** In many parts of the world, access to salt, sugar, and fat is now immediate and easy. Humans may tend to "crave" these substances and find themselves unwilling or unable to limit intake of them.
- **D.** The abundance and easy availability of unhealthy and processed foods is exacerbated by a modern shift from active to sedentary lifestyles.
- **E.** Recent research suggests that the decreases in dietary quality and in activity levels now reach into far corners of the globe. Populations in the South Pacific and Africa provide good examples.

IV. Some anthropologists suggest that a partial return to an ancestral diet may have ameliorative benefits for some modern populations.

- **A.** Practitioners of a new cottage industry based on *paleonutrition* suggest that modern humans could improve their health by adopting some of the dietary and lifestyle habits of our hominid ancestors.
- **B.** Some anthropologists embrace (and contribute to) this movement. Others point out that there was too much variation in the hominid past to forge any kind of self-help plan based on a homogeneous conception of how hominids lived.
- **C.** Whether or not specific pieces of advice are adopted, the field of biological anthropology can increase one's awareness of how modern habits have departed significantly from those that shaped our species.

Essential Reading:

Jurmain et al., *Introduction to Physical Anthropology*, chapter 16.

Somer, *The Origin Diet: How Eating Like Our Stone Age Ancestors Will Maximize Your Health*.

Supplementary Reading:

Consult www.PaleoDiet.com.

Questions to Consider:

1. Why have fat buffers been particularly important for women, more so than for men, throughout human evolution?
2. Do you think that that the notion of an evolutionary predisposition for sugar, fat, and salt could be helpful in selecting a healthy lifestyle in today's world?

Lecture Twenty-Two
The Body and Mind Evolving

Scope: We have just explored the idea that the human diet may now be "out of whack" with our evolutionary history. This analysis leads to a larger question: Can twenty-first century human wellness, both physical and emotional, really be so heavily influenced by events that occurred thousands, and maybe even millions, of years ago?

In some ways, the answer is a crystal-clear "yes." The underlying claim of this course is, after all, that we can better understand ourselves by looking to our past. To the case we have been building all along, we can add three new data points.

First, we consider the phenomenon of morning sickness found among pregnant women. Now treated as pathology by most physicians, the perspective of evolution suggests that it may, in fact, be a quite adaptive response.

Next, we shift time periods to the more recent history of *Homo sapiens.* Surprising new explanations have been published for why the rate of high blood pressure differs between different populations in the United States.

Finally, we investigate the burgeoning field of evolutionary psychology, which extends evolutionary analysis into the area of human emotions and preferences. A "hot topic" in evolutionary psychology is human mate choice.

Dangers exist, however, in the idea that the selection pressures of our hominid past somehow determine our physical or emotional health. We conclude this lecture by affirming that the human species has evolved with a premium on behavioral plasticity.

Outline

I. In earlier lectures, we proposed that certain aspects of modern human life can be explained by examining not only culture but also biological pressures from our past. Does this evolutionary influence apply only to skin color, human heat tolerance, and dietary preferences, or might it extend to many more areas of physical and emotional health?

- **A.** Our first step is to see how radically new is this question. As we have seen, acceptance of human biological evolution came slowly (and is still not complete). Using an evolutionary perspective to illuminate human health (of body and mind) is still in its infancy.
- **B.** The term *Darwinian medicine* has been coined to acknowledge the fact that some co-called diseases, syndromes, or symptoms might, in fact, have evolved for adaptive reasons. Fever presents us with a quick introductory example.

II. The phenomenon of morning sickness during human pregnancy affords a good opportunity to consider the pros and cons of applying the evolutionary perspective to modern health.

- **A.** As defined by Margie Profet, morning sickness includes feelings of nausea and food aversions, most often during the first trimester.
- **B.** Virtually all women in all cultures experience some degree of morning sickness.
- **C.** Women and their doctors often treat morning sickness as an unpleasant and unnecessary side effect of pregnancy; it sometimes causes concern and alarm among women.
- **D.** Profet points out that the concentration of morning sickness during the first trimester coincides with the period of organ formation in the developing human fetus. Morning sickness may be an adaptive response that has evolved to protect the vulnerable fetus from maternal ingestion of toxins.
- **E.** In our evolutionary past, the foods most available to hominids would likely have included those containing high levels of toxins dangerous to the fetus.
- **F.** Women today who experience a moderate (rather than only slight or very severe) level of morning sickness may be feeling exactly what evolution has designed them to feel to best protect their babies.

III. Health issues may also be studied by focusing on more recent population histories, as is illustrated by new reports on hypertension in the United States.

- **A.** Hypertension, or high blood pressure, exists at higher rates in African-Americans than it does in white Americans in this country.
- **B.** Researchers expected to find that African-Americans ate more salt than their white counterparts, thus accounting, at least in part, for the raised blood pressure. This dietary difference turned out to be absent.
- **C.** Scientists who are tuned in to the evolutionary perspective note some key factors that together might explain the elevated blood pressure.
  - **1.** Many Africans were brought forcibly to this country from West Africa. Their areas of origin are thought to have had unusually little salt available. Peoples' kidneys would, in the distant past, have been selected to be efficient at processing what little salt was available.
  - **2.** Enslaved individuals were forced to endure torturous journeys en route to the Americas. In addition to other stresses, these people endured severe and prolonged thirst. Their kidneys would, thus, have undergone a type of intense "super-selection" for even more efficient uptake and processing of salt.
  - **3.** Under conditions of slavery, this bodily response would have been adaptive. Under current conditions, however, ingesting even typical levels of salt is dangerous because of the "hyperefficient" kidneys that are no longer adaptive.
  - **4.** As with the morning-sickness example, increased awareness of why certain individuals may experience medical problems (here, hypertension) may help patients and physicians alike agree on an effective course of treatment.

IV. The emerging field of evolutionary psychology borrows the principles we have been discussing and applies them to human emotions and choices. The underlying idea is that the evolution of the human mind has been as influenced by our ancestral past as the body, as can be seen through an analysis of human mate choice.

- **A.** Cross-cultural data point to a strong pattern in which human males choose their mates based on different criteria than do human females.
- **B.** Human males tend to select as mates women who are youthful and physically attractive; females tend to use criteria related to status and ability to acquire resources.
- **C.** Some anthropologists suggest that we can use the hominid past to understand this sex difference.
  - **1.** Because women are the ones who bear and nurse offspring, their youth and health are critically important. These qualities are signaled to males by their appearance.
  - **2.** By contrast, the male's critical contribution to reproductive success (after conception) may involve acquisition of resources. Status and power, sometimes correlated with older rather than younger age, may signal to females the male's reproductive ability.
  - **3.** Greater male than female sexual jealousy is predicted from this evolutionary model and appears borne out by the data.

V. Skeptics, both biological anthropologists and others, fear that Darwinian medicine and evolutionary psychology veer too close to biological determinism.

- **A.** The reliance of both these fields on the so-called "environment of evolutionary adaptedness" may be spurious. Very little is known about the social groupings and social behaviors of hominids (at least until Neandertal times and beyond); surely, these varied widely according to local circumstances.
- **B.** The social context, together with learned traditions, plays an enormous role in how symptoms of morning sickness or hypertension are actually experienced and how mate choice unfolds. To lay these patterns at the door of a single set of past selection pressures produces a simplistic picture.
- **C.** We may conclude that the evolutionary perspective has merit when applied to the human body and mind. What we should not do is empower past selection pressures to the exclusion of social learning and flexibility, which are equally key facets of the human evolutionary past.

Essential Reading:

Profet, *Pregnancy Sickness: Using Your Body's Natural Defenses to Protect Your Baby-to-Be*.

Supplementary Reading:

Cosmides et al., *What Is Evolutionary Psychology: Explaining the New Science of the Mind* (forthcoming in spring 2003).

Questions to Consider:

1. What main points support the claim that morning sickness is an evolved mechanism for protection of the human fetus? Can you think of any evidence that detracts from this claim?

2. The concept of variation is central to any understanding, or application, of evolutionary theory. In what ways does evolutionary psychology neglect this critical concept?

Lecture Twenty-Three
Tyranny of the Gene?

Scope: We have just emphasized human social learning and flexibility as twin pillars of the human evolutionary legacy. Yet, in academic and popular science, many of the latest "hot topics" revolve not around the interplay of biology and culture but around the role of genes in determining human behavior and health.

Americans are currently bombarded with news stories about discoveries related to sequencing the human genome, the potential for gene therapies in conquering various diseases, and the volatile issue of cloning. We are even invited to consider cloning our pets! Analysis of pet cloning serves to show how dangerously oversimplified "gene discourse" has become—and how this oversimplification may affect the way we think about our own lives.

Despite the promise of genetic "quick fixes," the truth is that genes are just one part of a complex interrelated system. Genes do not determine appearance or health, let alone behavior. Discourse implying that genes will unlock new secrets of human health and happiness in the next century deserves skeptical analysis.

Outline

I. In the words of the philosopher of science Evelyn Fox Keller, "never in the history of the gene has the term had more prominence."

- **A.** We live now in an era that looks to the gene not only as a major explanatory factor in aspects of present-day health and behavior but also as a vehicle to improve health and behavior in the future.
- **B.** The media find enormously "sexy" such topics as sequencing the human genome, genetic therapies for human diseases, and the ethics of cloning. The power of the gene is virtually taken for granted in these presentations: If genetic problems exist, modern science can fix them by understanding and working with the gene.
- **C.** An accurate scientific picture of the gene clarifies that only very rarely is there a 1:1 relationship between a gene and a specific outcome (whether physical or behavioral). Even a 1:1 relationship between a gene and the production of a specific protein is unusual.

II. A good place to start in exploring these topics is pet cloning.

- **A.** Among the animals that have now been successfully cloned is the domestic cat; this feat was front-page news in 2002.
- **B.** Biotechnology companies now advertise widely available cat cloning as a coming reality; they invite customers to freeze their pets' tissue samples for future genetic duplication.
- **C.** Although the fine print in these advertisements does refer to "slight differences," including those in appearance, between donor animal and resultant clone, the selling point is that people will be able to resume life with a beloved lost pet.
- **D.** In point of fact, the assumption that cloning produces a near-duplicate creature is seriously flawed. Just as with people, an animal's personality and even its appearance, including such major features as coat color, emerge from a dynamic and unpredictable relationship between genes and the environment.

III. How do the lessons of pet cloning apply to human concerns more directly?

- **A.** In 2000, the Human Genome Project succeeded in sequencing all the DNA and, thus, identifying all the genes in a "typical human cell." This "cracking of the human genome" was heralded as an enormous breakthrough for humankind.
  1. As the anthropologist Jon Marks has pointed out, "*the* human genome" is a misleading term. Owing to genetic diversity, there is more than one human genome.
  2. Although identifying the DNA sequence in a human cell is indeed impressive, it is not the prize in itself, because it tells us nothing about the function of genes. Genes act not singly but in complex combinations and unpredictable ways.

- **B.** Genetics research may hold out real hope for medical progress in certain areas, but this hope is routinely inflated in the media.
  - **1.** The effect of some diseases may be ameliorated because we understand the genes' role in them. Cystic fibrosis and Tay-Sachs are examples of diseases in which single genes have been implicated.
  - **2.** The vast majority of diseases responsible for human suffering or mortality are not the result of single genes; heart disease, stroke, diabetes, and depression come about for complicated biological and social reasons.
  - **3.** The persistent tendency to think in 1:1 terms may lead to suggested correlations between genes and personality traits ("You may have a gene for shyness; does your spouse have a gene for risk-taking?"). These have no basis in scientific fact.
  - **4.** Just as with pet cloning, the public's expectations in the area of gene therapy have been raised in inaccurate and unrealistic ways.

IV. We return to the words of Evelyn Fox Keller in noting "how large [is] the gap between genetic 'information' and biological meaning…"

- **A.** Genes should be thought of in two fundamentally different ways.
  - **1.** Genes are structural entities that get passed along from generation to generation and that can be isolated and studied as single elements in the research laboratory.
  - **2.** Genes are functional entities in a very different sense. They have no straightforward functional identity of their own but play a role in dynamic interaction within a larger system.
- **B.** Improving human life and health does not depend primarily on genetics research. Rather, it requires a solid understanding that the quality of human existence depends on the interaction of many processes, some biological and some social. Biological anthropology provides a window into this complex understanding.

Essential Reading:

Keller, *The Century of the Gene*.

Marks, *What It Means to Be 98% Chimpanzee*, chapter 9.

Questions to Consider:

1. Why do you think the media, and some factions of the public, are so quick to embrace "gene discourse"?

2. What does it mean to say that genes have no functional identity of their own?

Lecture Twenty-Four
Evolution and Our Future

Scope: Is there any truth to the joke that humans are gradually evolving a new physical form, perhaps best termed *Homo sedentarius obesus*? Can we, in fact, predict how human bodies and minds might change and adapt in the future? Might some future speciation event result in the coexistence of multiple hominids on Earth, as once was common?

These questions can be approached with information about our evolutionary past, as can similar ones about how increases in human population may affect the other creatures with which we share this planet. The knowledge gained from biological anthropology, however, can lead us to reflect with deeper understanding on two issues of even greater overarching importance to humanity.

The first issue can be summarized by the term *continuity.* Taking "the long view" of human history allows us to recognize and appreciate our close kinship with other primates, whether living or extinct. We are not just related to these other species in some distant, technical way, as can be represented by comparisons of DNA or on evolutionary timelines. Rather, our continuity with monkeys, apes, and hominids plays out vitally in our everyday lives, in the way we parent and educate our children, in our reliance on problem-solving technology, in the comfort we take in our symbolic rituals and ceremonies, and in our mobile lifestyle.

The second issue can be summarized by the term *dynamic interaction.* We humans live today in dynamic interaction with every other creature on Earth: every animal, plant, and ecosystem; every human across the room, across the street, across the country, and across the planet. What each of us does affects, in contingent and unpredictable ways, what happens elsewhere. That we live in our world dynamically reflects how we have evolved; we are the result of millions of years of dynamic interplay between biology and culture, between genes and social learning.

Outline

I. Science fiction writers love to imagine the evolutionary future of *Homo sapiens.* Will we evolve larger heads to cope with the Information Age? Will our bodies dwindle even as our heads enlarge, because we have become so sedentary?

- **A.** As a step toward considering our future, let us remember how very young a species we are. We have been a species for perhaps 125,000 years, and the sole hominid for only 30,000 years.
- **B.** Biological anthropology teaches us that we cannot predict the precise ways in which we will change as our species moves beyond its infancy. Any traits that are naturally selected are those that will allow differential reproductive success in the surrounding environment, yet shifts in that environment are not foreseeable.
  - **1.** The robust australopithecines, now considered "failed" species, nonetheless lived about a million years. This is nearly ten times as long as we have existed so far. Their apparent dietary "overspecialization" becomes clear only in hindsight.
  - **2.** As the biological anthropologist Chris Stringer points out, the trend in hominid evolution for millions of years was to get heavier-boned and stronger. Only recently did that trend reverse, with selection acting to choose lighter-boned, more gracile creatures. This change was not predictable.

II. Evolutionary scenarios featuring large heads and small bodies, or increasing obesity, are fanciful. More worthy of our effort is recognizing that selection pressures are not a one-way street.

- **A.** Courses on human evolution place our species squarely at their center. They depict *Homo sapiens* as having evolved because we met certain challenges and adapted to various selection pressures. Less prominent is the idea that we generate selection pressures, as well as cope with them.
- **B.** Hominids always existed as part of a community of plants and animals, with reciprocal selection pressures at work.
  - **1.** Evidence of this can be seen back in early hominid times when, for example, big cats were predators on human ancestors.

2. Current predators—and selection pressures—on humans include the viruses that cause AIDS and ebola.

C. *Homo sapiens* now exists in unprecedented numbers; there are 6 billion of us. Our actions create selection pressures on an unprecedented scale for the animals and plants with which we share the Earth.
1. The disappearance now underway of animal life differs in kind from earlier mass extinctions.
2. Logging by humans in the Amazon and Congo basins allows us to see the processes at work that may lead to more species extinctions in the future.
3. Social learning and collective activism can still turn around the bleak picture that ecologists paint of future animal extinctions.

III. Humans are simultaneously influenced by their evolutionary past, in the process of adapting to current local conditions, and capable of rapid social learning and cultural change.

A. We are and will remain one species, divided only into populations that undergo a great deal of gene flow.
1. All populations of *Homo sapiens* are fundamentally equal in the biological sense. Access to resources, including healthy food and good medical care, is not equal across populations of *Homo sapiens.*
2. Differential stresses across populations will not result in biological speciation. Human mobility and mating between groups occurs at levels unparalleled in history. One estimate suggests that 1 million people cross national borders in an airplane every single day.

B. The simultaneous facts of our biological equality and our constructed social inequality constitute a challenge for humanity. We must not forget what it means that we are a *single species*, linked with each other across populations and living in a community with other species. This knowledge may help reassert priorities and perspective in today's world.

IV. In sum, biological anthropology can help us reflect on two specific issues of supreme importance to humanity.

A. Our relationship with other primates, whether the living monkeys and apes or the extinct hominids, is one of continuity. Please think back on some examples we have reviewed in this course and consider the links with human behavior:
1. Monkey mothers, organized into matrilines, tend to treat their kin preferentially as compared with non-kin.
2. Chimpanzee mothers respond with guidance and teaching when they realize that their offspring or close friends lack knowledge in certain situations.
3. The archaeological record reflects that once early hominids figured out how to modify stone tools, they began to invent more types of tools, each made in more efficient ways. Sometimes progress was slow, but problem solving with technology increased over time.
4. Neandertals no longer discarded or left to the elements the bodies of deceased relatives and friends; rather, they began to bury their dead. At times, the bodies were buried along with objects of apparent value, likely reflecting some degree of ritual and ceremony.
5. From the time period of *Homo erectus* onward, hominids were not content to stay put, near to where they had been born; rather, they traveled and explored new worlds. The Exploration Age might well be considered to have started 2 million years ago!

B. This continuity means that our modern-day behavior is built on the evolutionary legacy of our past. But human evolution has been too dynamic for us to conclude that our current condition is the result of biology or genes.
1. Let's think about what the concept *dynamic* really implies. Change, yes, but what else? Key elements of dynamic interactions are contingency (things might have turned out another way) and unpredictability (the outcome cannot be known at the start).
2. Human evolution has been dynamic in the sense that our biology and our culture cannot be separated out from each other; their relationship is closely intertwined, contingent, and unpredictable. The same goes for the relationship between genes and social learning. Biological anthropology teaches us that we must understand this complexity to fully cope with the challenges of our future.

Questions to Consider:

1. What is meant by the term *reciprocal selection pressures*?

2. In what ways have we humans evolved dynamically? What lessons does this knowledge carry for us as we move into the twenty-first century?

Timeline

Prehistory

(**Note**: Biological anthropologists frequently revise these dates, updating them according to new information. Included here are the current best estimates. The abbreviation *mya* stands for "million years ago.")

70 mya .... Age of Dinosaurs nears an end; no primates yet exist

65 mya .... Age of Mammals begins; ancestral primates appear

55 mya .... Earliest definite primate

55–6 mya .... Numerous speciation events produce ancestors to today's prosimians, monkeys, and apes

8–7 mya .... Common ancestor to African apes and hominids

approx. 7 mya .... First hominid, perhaps *Sahelanthropus tchadensis*

4.2 mya .... First australopithecines

3.2 mya .... Time at which "Lucy" lived (*Australopithecus afarensis*)

2.5 mya .... First hominid-modified stone tools

2.4 mya .... First hominid in the *Homo* genus, *Homo habilis*

1.9 mya .... First *Homo erectus*, in Africa

1.8 mya .... Some populations of *Homo erectus* migrate out of Africa to Asia

130,000 .... First Neandertals

125,000 .... First *Homo sapiens*

30,000 .... Disappearance of Neandertals; *Homo sapiens* is the only surviving hominid

History

1856 .... First Neandertal discovery, in Germany

1859 .... Charles Darwin publishes *On the Origin of Species*

1891 .... First *Homo erectus* discovery, in Java

1924 .... Raymond Dart finds first australopithecine, in South Africa

1925 .... Scopes Monkey Trial in Tennessee

1951 .... Sherwood Washburn outlines the new physical anthropology

1960 .... Jane Goodall begins observations of wild chimpanzees

1968 .... Washburn and Lancaster publish "Man the Hunter" paper

1974 .... Don Johanson uncovers "Lucy" in Ethiopia

1978 .... Glyn Isaac publishes theory on *Homo habilis* behavior

1984-1985...................................... Discovery of "Nariokotome Boy" (*Homo erectus*) in Kenya

1990s .... Excavation of African sites showing that early modern behavior did not originate exclusively in Europe

2002 .... Announcement of the fossil discovery *Sahelanthropus tchadensis* from Chad, currently considered the oldest hominid known to science

Glossary

(**Note**: For names of specific primates, please refer to the Species Sketches section.)

Acclimatization: A physiological process of adaptation, as to extreme climate, in either the short or long term.

Adaptive radiation: Rapid expansion of new animal forms into new habitats.

Anthropoids: One of the two major groupings of primates; the anthropoids are diverse, including all the monkeys, apes, extinct human ancestors, and modern humans.

Apes: A subset of anthropoids that tends to be large-bodied and includes humans' closest living relatives.

Biological anthropology: The subfield of anthropology that takes as its subject matter the evolution, genetics, and anatomy of, and modern variation within, the human species.

Conceptual model: Model that focuses on evolutionary processes rather than specific organisms in trying to understand the behavior of extinct human ancestors.

Differential reproductive success: Refers to the fact that within a population, some individuals will produce more healthy offspring than others.

Evolution: Change in the genetic structure of a population.

Gene: A sequence of DNA that can be passed on to offspring.

Gene flow: One of the major mechanisms of evolution; refers to the exchange of genes between populations.

Gene pool: All the genes shared by members of a single population.

Genetic drift: One of the major mechanisms of evolution; occurs in small populations when random events shift the composition of the gene pool.

Gracile: Relatively light-boned and slender.

Hominids: Primates, including those that led to modern humans, characterized by bipedalism; evolved after the evolutionary split with the great apes.

Homology: A similarity based on shared descent (if two primates have homologous traits, the traits are alike owing to a common evolutionary heritage).

Iconic gesture: Gesture that indicates the specific action that the gesturer wishes another animal or person to take.

Intelligent design: A set of beliefs predicated on the idea that some organs and organisms, such as humans, are so complex that they could have arisen only by design (not by unguided evolutionary mechanisms).

Matriline: A group of related females.

Mitochondrial DNA (mtDNA): Inherited only through the maternal line and, thus, changed only via mutation, mtDNA is a possible tool for tracing descent lines in prehistory.

Monkeys: A diverse set of anthropoids that are relatively small-bodied, more distantly related to humans than are the apes.

Multiregional model: One of two major models for the origins of modern humans; this one suggests that *Homo sapiens* evolved from earlier hominids on three continents at about the same time in response to regional selection pressures.

Mutation: One of the major mechanisms of evolution; refers to a change in the structure of DNA within a gene.

Natural selection: The single most important mechanism of evolution; refers to the fact that some individuals within any population will be better adapted to their local environment than others, leading to greater reproductive success.

Out-of-Africa replacement model: One of two major models for the origins of modern humans; this one suggests that *Homo sapiens* evolved first in Africa, then spread out to other areas and replaced all other hominids.

Patriline: A group of related males.

Phylogenetic model: Model that proposes taking into account the behavior of all four great apes in trying to understand an extinct human ancestor.

Population: Members of a species that share a common gene pool and mate more with one another than with members of other populations.

Primates: Division of mammals that includes all prosimians, monkeys, apes, extinct human ancestors, and modern humans.

Prosimians: One of the two major groupings of primates; the prosimians evolved first and are relatively specialized.

Punctuated equilibrium: The idea that evolution may sometimes proceed in rapid leaps rather than always by small, gradual modifications.

Race: A term used to suggest that humans can be sorted into distinct groups based on genetic traits, such as skin color or nose shape. Almost all biological anthropologists agree that this term has no biological validity.

Referential model: Model that proposes a 1:1 relationship between the behavior of some living primate and an extinct human ancestor.

Robust: Heavy-boned and strong.

Scientific creationism: A set of beliefs predicated on the ideas that the Earth is young and humans were created by a supernatural force within the last 10,000 years.

Sexual dimorphism: Anatomical differences based on one's sex.

Speciation: The process by which new species are formed from existing ones.

Species: A grouping of organisms whose members can all interbreed with one another and produce fertile offspring. The species is a larger grouping than the population.

Theory: In science, a set of principles that has been supported by observation and testing.

Theory of mind: The ability to take into account the mental perspective of another.

Species Sketches

Australopithecus afarensis: A gracile hominid species that includes "Lucy" and lived in Africa from about 3.6 to 3 million years ago.

Australopithecus africanus: The first australopithecine to be discovered, this gracile African form lived from perhaps 3.6 to about 2 million years ago.

Australopithecus anamensis: An African hominid dating to about 4.2 million years ago.

Australopithecus robustus and ***Australopithecus boisei***: Two robust hominids that lived in Africa along with gracile forms but eventually went extinct, apparently due to dietary overspecialization.

Bonobo: One of the African great apes; lives in bisexual communities with greater emphasis on female-female bonds than is found in the chimpanzees.

Chimpanzee: One of the African great apes; lives in bisexual communities with greater emphasis on male dominance than is found in the bonobos.

Gelada baboon: An Old World monkey that lives in one-male units; females bond with one another to prevent domination by males.

Gorilla: One of the African great apes; lives in either one- or two-male groups.

Great apes: Humans' closest living relatives, these large-bodied and large-brained apes are the orangutan, gorilla, chimpanzee, and bonobo.

Hamadyras baboon: An Old World monkey that lives in one-male units; males dominate females, harassing and biting them.

Homo erectus: The first hominid to live in Asia as well as Africa, this species, which includes the "Nariokotome Boy," is thought of as a turning point in human evolution. Appearing at about 1.9 million years ago, its "endpoint" is hotly debated but may be about 400,000 years ago.

Homo habilis: The first hominid in our own genus, this species is famous for being the first (as far as we know!) to manufacture stone tools. It lived in Africa from about 2.4 to 1.9 million years ago.

Homo neandertalensis: See **Neandertal**, below.

Homo sapiens: Modern humans; us. Modern human anatomy developed at perhaps 125,000 to 100,000 years ago.

Kenyanthropus platyops: Flat-faced hominid of Kenya, discovered by Maeve Leakey, that existed at about 3.5 million years ago. This species thus overlapped in time with *Australopithecus afarensis*.

Lesser apes: Small-bodied apes of Asia, including gibbons, that usually live in monogamous pairs.

Marmoset: A small New World monkey that lives in extended family groups.

Muriqui: A relatively large New World monkey that lives in peaceable social groups largely devoid of relative ranking.

Neandertal: Hominid that is likely a separate species from modern humans but overlapped with them in time and place. The Neandertals lived in Asia and Europe from about 130,000 to 30,000 years ago.

Orangutan: The only Asian great ape and the least social of all apes.

Orrorin tugenensis: A very old African hominid, dated to about 5.8 million years ago; dethroned by *Sahelanthropus tchadensis* in 2002 as the "oldest known hominid."

Rhesus monkey: An Old World monkeys organized into matrilines with great emphasis on dominance hierarchies.

Ring-tailed lemur: A group-living African prosimian in which females are routinely dominant to males.

Sahelanthropus tchadensis: Best current candidate for the oldest hominid, at about 7 million years ago; announced in 2002 by scientists working in Chad, central Africa.

Savanna baboon: An Old World monkey organized into matrilines and heavily dependent on dominance hierarchies.

Slow loris: A nocturnal Asian prosimian that is far more social than expected for such a primate.

Transitional hominid species: The catchall term we use to refer to those hominids that lived after ***Homo erectus*** but before ***Homo sapiens***, with a mix of *erectus-sapiens* traits. These hominids are found in Africa, Asia, and Europe.

Bibliography

Essential Reading:

De Waal, Frans. *Tree of Origin: What Primate Behavior Can Tell Us About Human Social Evolution.* Cambridge, MA: Harvard University Press, 2001. This edited collection, with contributed chapters from leading scholars, demonstrates beautifully the ways in which specific studies of monkeys and apes can shed light on our hominid ancestry.

Gould, Stephen Jay. *The Structure of Evolutionary Theory.* Cambridge, MA: The Belknap Press of Harvard University Press, 2002. Published just before his death, this volume is Gould's *magnum opus.* It explains how newer concepts can be integrated with Darwin's insights to produce a comprehensive vision for understanding evolution. At well over 1,000 pages, the volume is formidable, but selected chapters are well worth the effort for the serious student.

Johanson, Don, and Maitland Edey. *Lucy: The Beginnings of Humankind.* New York: Simon and Schuster, 1981. A fact-filled, enjoyable account of Lucy's discovery specifically and theories of human evolution generally, this book gives an excellent feel for what it is like to be a fossil hunter in Ethiopia. It must be read in the context of the course, however; some of its conclusions about Lucy's place in the human family tree have been overturned by newer information.

Jurmain, Robert, Harry Nelson, Lynn Kilgore, and Wenda Trevathan. *Introduction to Physical Anthropology,* 8th edition. Belmont, CA: Wadsworth Publishing, 2000. The text of choice for many biological anthropologists, this book provides vital background information on the topics covered in this course. It includes superb visuals (photographs, charts, diagrams). The chapters cited as essential reading at the end of each lecture are keyed to the 8th edition, but newer editions, when available, would be even better.

Keller, Evelyn Fox. *The Century of the Gene.* Cambridge, MA: Harvard University Press, 2000. Written elegantly and aimed at non-experts, this book examines what genes are and what they are not (and how that understanding has changed as new knowledge accumulates). Keller shows that we cannot understand genes as isolated units, but must instead, study them at work as part of a larger biological system.

King, Barbara J. *The Origins of Language: What Nonhuman Primates Can Tell Us.* Santa Fe, NM: School of American Research Press, 1999. Lecture Eighteen relies heavily on this volume's contribution by Burling, who creates a plausible scenario of the evolution of language from ape gesture. Other chapters are useful for understanding the evolutionary transition from nonhuman primate communication to human language.

Marks, Jonathan. *What It Means to Be 98% Chimpanzee: Apes, People, and Their Genes.* Berkeley, CA: University of California Press, 2002. Marks's title refers to the oft-cited statistic that humans and chimpanzees share 98% of their genes. But what does this really mean? In his typically engaging style, Marks examines not only this question but others related to human "race" and variations that spring from it.

Natural History, April 2002 issue. Two features in this issue explain in clear terms issues of relevance to this course. First is a series of short opinion pieces that together constitute a written debate between evolutionary theorists and intelligent design advocates. Second is the column by science writer Carl Zimmer on evolution of the eye.

Profet, Margie. *Pregnancy Sickness: Using Your Body's Natural Defenses to Protect Your Baby-to-Be.* Cambridge, MA. Perseus, 1997. A readable account of Profet's fascinating theory that pregnancy sickness is a long-ago evolved adaptation to protect the developing fetus.

Scientific American, July 2002 issue. The no-holds-barred title of John Rennie's article says it all; "15 Answers to Creationist Nonsense" refutes myths and misunderstandings related to basic concepts in evolutionary theory.

Somer, Elizabeth. *The Origin Diet: How Eating Like Our Stone Age Ancestors Will Maximize Your Health.* New York: Owl Books, 2002. As a registered dietician, Somer does an intriguing job of suggesting ways in which knowledge of paleonutrition might improve our lives today.

Sykes, Bryan. *The Seven Daughters of Eve: The Science That Reveals Our Genetic Ancestry.* New York: W.W. Norton and Co., 2001. Genetics professor Sykes writes about the uses to which mitochondrial DNA may be put in clarifying issues in human evolution. He tackles controversies, such as how closely related Neandertals are to modern humans, and gives his perspective on the origins of modern *Homo sapiens.*

Tattersall, Ian. *The Last Neanderthal: The Rise, Success, and Mysterious Extinction of Our Closest Human Relatives*. Boulder, CO. Westview Press, 1999. A paleoanthropology curator at the American Museum of Natural History in New York, Tattersall has written a string of valuable books on human evolution. This one is particularly welcome for its illustrations that wonderfully bring to life the Neandertals.

Weiner, Jonathan. *The Beak of the Finch: A Story of Evolution in Our Time.* New York: Knopf, 1994. Reviewers have noted that this Pulitzer-Prize-winning account reads like a thriller! It details research done by the Grants, a husband-and-wife team of biologists that has carried out modern-day evolutionary studies on the finch populations in the Galapagos Islands—the descendant birds of those studied by Charles Darwin.

Supplementary Reading:

Behe, Michael. *Darwin's Black Box: The Biochemical Challenge to Evolution.* New York: Free Press, 1996. This book, billed by some as "a scientific argument for the existence of God," presents one case for an intelligent design perspective. It can be read as an alternative to the evolutionary thinking that is the foundation for this course.

Blakey, Michael. "Bioarchaeology of the African Diaspora in the Americas: Its Origins and Scope." *Annual Review of Anthropology* 30:387–422, 2001.

Cosmides, Lena, John Tooby, et al. *What Is Evolutionary Psychology: Explaining the New Science of the Mind.* New Haven, CT. Yale University Press (forthcoming in 2003). This book promises to be a lively and lucid account of the principles of the emerging field of evolutionary psychology.

Jolly, Alison. *Lucy's Legacy: Sex and Intelligence in Human Evolution.* Cambridge, MA: Harvard University Press, 1999. An always literate, sometimes amusing analysis of how issues of sex and gender figure into primate behavior and human evolution.

Potts, Richard. *Early Hominid Activities at Olduvai.* Aldine de Gruyter, 1988. The Smithsonian Institution's Potts lays out a fascinating behavioral framework for interpreting the hominid sites at Olduvai Gorge, Tanzania. Particularly enlightened is his alternative formulation to a long-accepted model of *Homo habilis* behavior.

Sapolsky, Robert. *A Primate's Memoir.* New York: Scribner, 2001. An informative and fun account by a distinguished primatologist, MacArthur "genius" award winner, and Teaching Company faculty member. He writes about his many years in Kenya studying wild baboon behavior.

Savage-Rumbaugh, E. S., and R. Lewin. *Kanzi: The Ape at the Brink of the Human Mind.* New York: Wiley, 1994. The accomplishments of the bonobo Kanzi, who can produce and comprehend symbolic utterances, are chronicled in this volume.